Going the Distance

A LEGO® Education STEAM Program

BricQ Motion Essential

STEAM Program

LEGO® Education BricQ Motion Essential Advanced Program

Program Overview:

This 4-day program outline will provide students with STEAM focused hands on activities to promote 21st century skills as well as design engineering. Each day, students will participate in team building activities, engage in opportunities for physical activity, and 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 designing a new Olympic event.

	Essential Questions	Daily Activities
Day 1	**Welcome to Orientation** What forces make a derby car move?	Push Car Derby Race Car
Day 2	**Balancing Act** How do balanced and unbalanced forces affect objects?	Weightlifter Tight Rope Walker
Day 3	**Going Down** How does gravity affect the movement of a vehicle?	Gravity Car Relay Race
Day 4	**A New Olympic Event** What are different ways you can make a mechanism move?	Dancers Create Your Own Olympic Event Play the Games

Prior to First Day of the Program:

1. Sort the BricQ Motion Prime sets.
2. Determine a naming convention for each set and label. Suggestions include school initials and a number (Example: Millcreek Elementary simple machine sets names could be MES1; MES2; MES3) and write name on the battery pack and the motor and on the set.
3. Gather any consumable materials needed for the week.
4. Determine a procedure for when a LEGO piece is dropped (everyone freeze; say LEGO® down/LEGO® found) and where to place LEGO® pieces if found and does not belong to the finder.
5. A BricQ Motion Essential Personal Learning kit is used by each student for the culminating activity on Day 4. If the Personal Learning kits will not be used, you will need to allow extra time for doing an inventory check at the end of the final day.

Going the Distance Day 1

Welcome to Orientation

Big Question:

- What forces make a derby car move?

Materials needed for the day:

- BricQ Motion Essential sets
- Chart paper
- Student journals (could be paper stapled together with students creating the outside of the journal using construction paper and other consumable materials)
- Graph paper
- Various craft materials
- Pens
- Pencils
- Markers
- Tape – masking, duct, painters, cellophane
- Measuring tapes

Outline of Day	**Tasks**	**Time**	**Materials**
9:00 - 10:30	Introductions	30 min	• BricQ Motion Essential sets
	Establishing Group Rules and Expectations	15 min	• Chart paper • Markers • Pens
	Team Building Activity	15 min	• BricQ Motion Essential sets • Objects such as water bottles or packs of sticky notes
	Team Briefing 1	5 min	• None

	Partner Selection, Team Name and Team Badge	25 min	• Team badge templates • Markers • Pencils • Scissors
10:30 - 10:35	Break		
10:35 - 11:25	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
	Design a Journal	20 min	• Student journals (see note in materials section) • Markers • Scissors • Construction paper • Other craft materials
	Reading and Wondering	20 min	• Book about car derbies • Student journals
11:25 - 11:30	Get ready for lunch		
11:30 - 12:00	Lunch		
12:00 - 2:10	Afternoon Huddle	5 min	• None
	Challenge 1: Push Car Derby	50 min	• BricQ Motion Essential sets • Building Instruction booklets • Student journals • Graph paper
	Break	5 min	• None
	Challenge 2: Relay Race	60 min	• BricQ Motion Essential sets • Building Instruction booklets • Student journals
	Disassemble and Inventory Sets	15 min	• BricQ Motion Essential sets • Building Instruction booklets • Student journals

2:10 - 2:30	Daily debrief and wrap up	20 min	• Student journals • Sticky notes

Introductions

Time: 30 minutes
Materials:

- BricQ Motion Essential sets

Purpose: For students to get to know each other

Using LEGO elements, have students build a model that shows something they really like to do and one thing they hope to learn during the STEAM program. When it is time to share, have students say their name and share their model. The teacher can record what the group hopes to learn on a piece of chart paper.

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 students sign the chart paper and then place the rules and expectations in a location that can be reviewed each day.

Team Building Activity

Time: 15 minutes
Materials:

- BricQ Motion Essential sets

You will need identical sets of bricks. For example, if you have 5 groups, you will need 6 sets of identical bricks- one for the model you build and one set for each team.

Relay race

- Introduce the Relay race activity as described below.
- Give the participants approximately 10 minutes to complete the activity.
- Create teams of 4-5 participants.

- Build and hide model of 12-15 LEGO® bricks, you decide how it looks – remember, it should not be too easy to copy!

Remember to say/cover the following points:

- Work in teams of 4-5.
- The facilitator builds a model of 12-15 bricks and hides it at the far end of the room, behind an obstacle.
- Teams line up and one from each team runs to see the model.
- When the team member returns to base, he/she can place one brick, then the next team member runs, etc.
- The aim is to copy the hidden model as fast as possible.

Tips

- Variations - the teams cannot talk while working on building the model

Morning Huddle

Time: 5 minutes
Materials: None

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*
- *Your company will create a ball moving machine by the end of the week*
- *Design a journal for keeping important records this week*
- *Explore different ways we use simple machines*

Partner Selection, Olympic Team Name, and Design a Logo

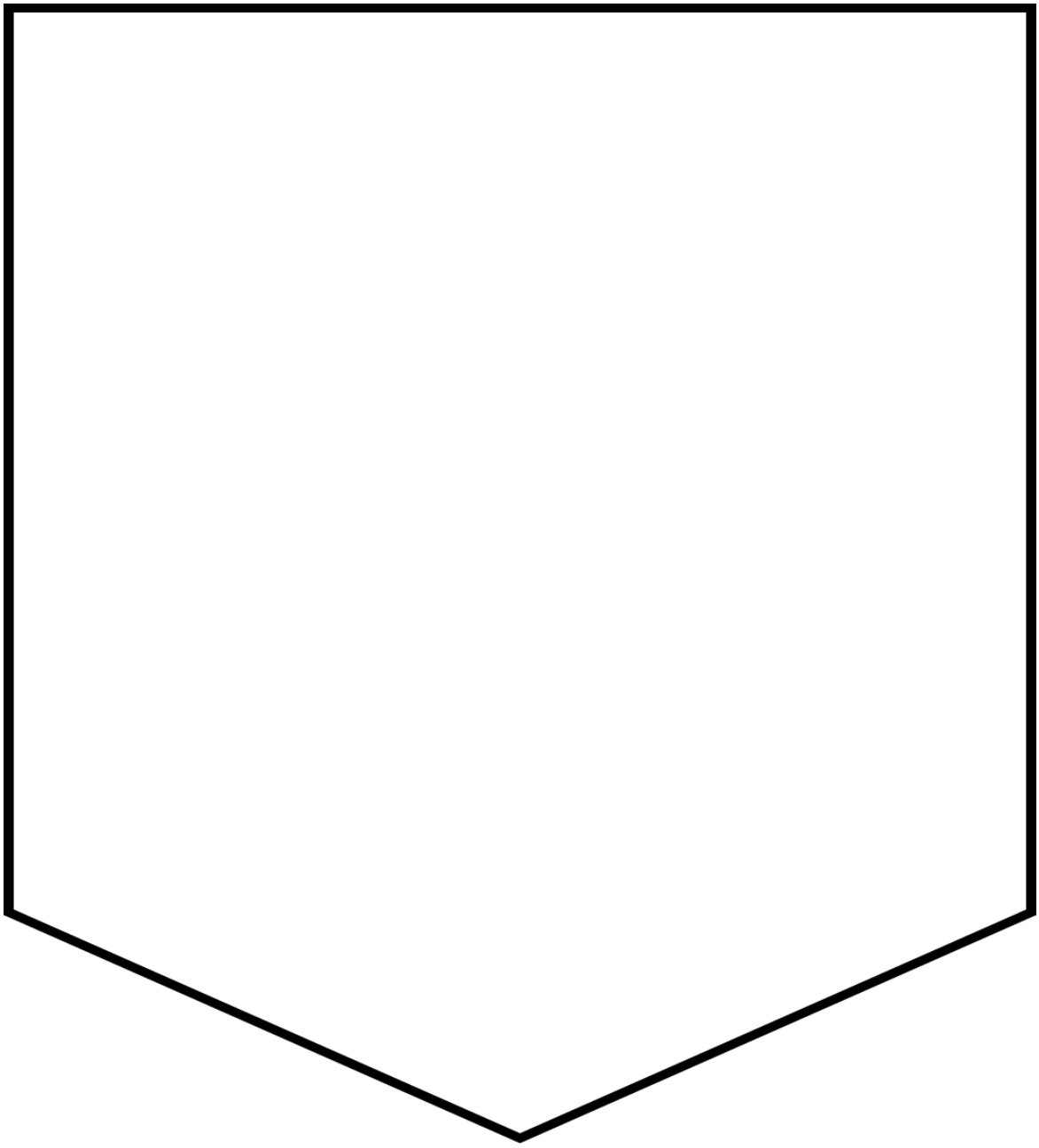
Time: 25 minutes
Materials:

- Markers
- Scissors
- Construction paper
- Other craft materials

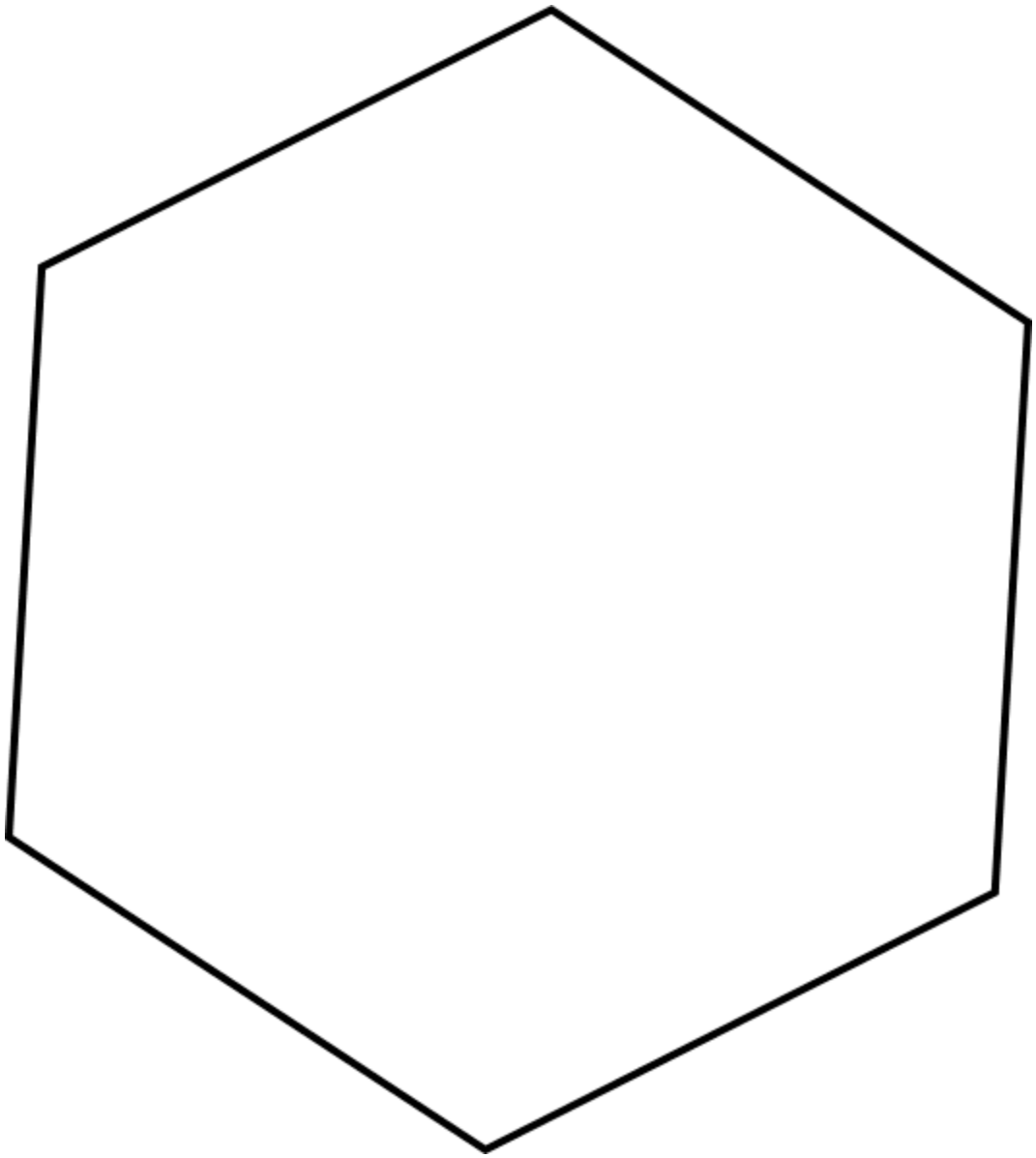
You can use several different activities to help students find a partner to work with for the week. An internet search can help you find several ideas.

Once partners have been established, student teams can determine an Olympic team name (team name) and design a logo.

Logo Templates



Logo Template



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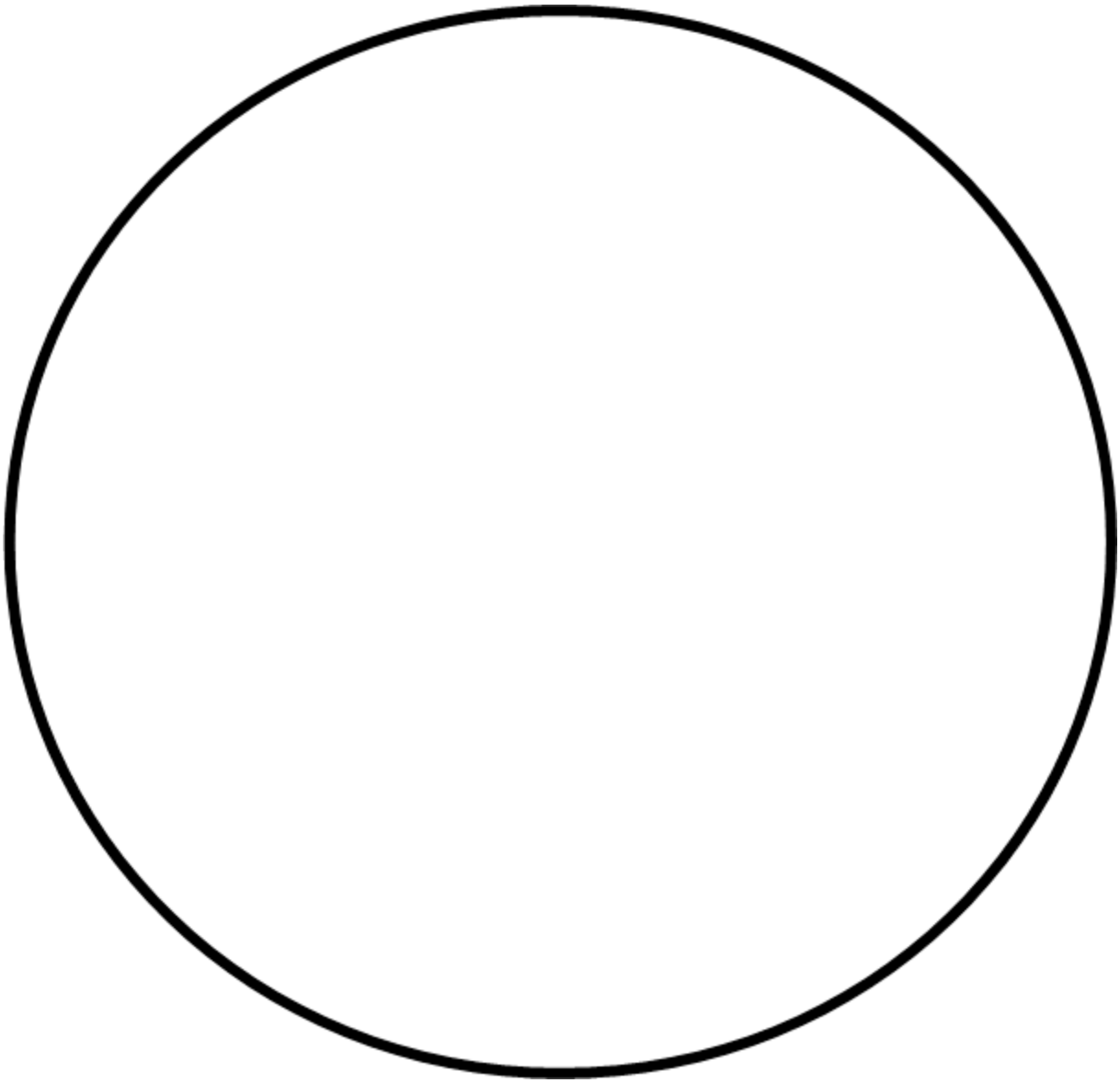

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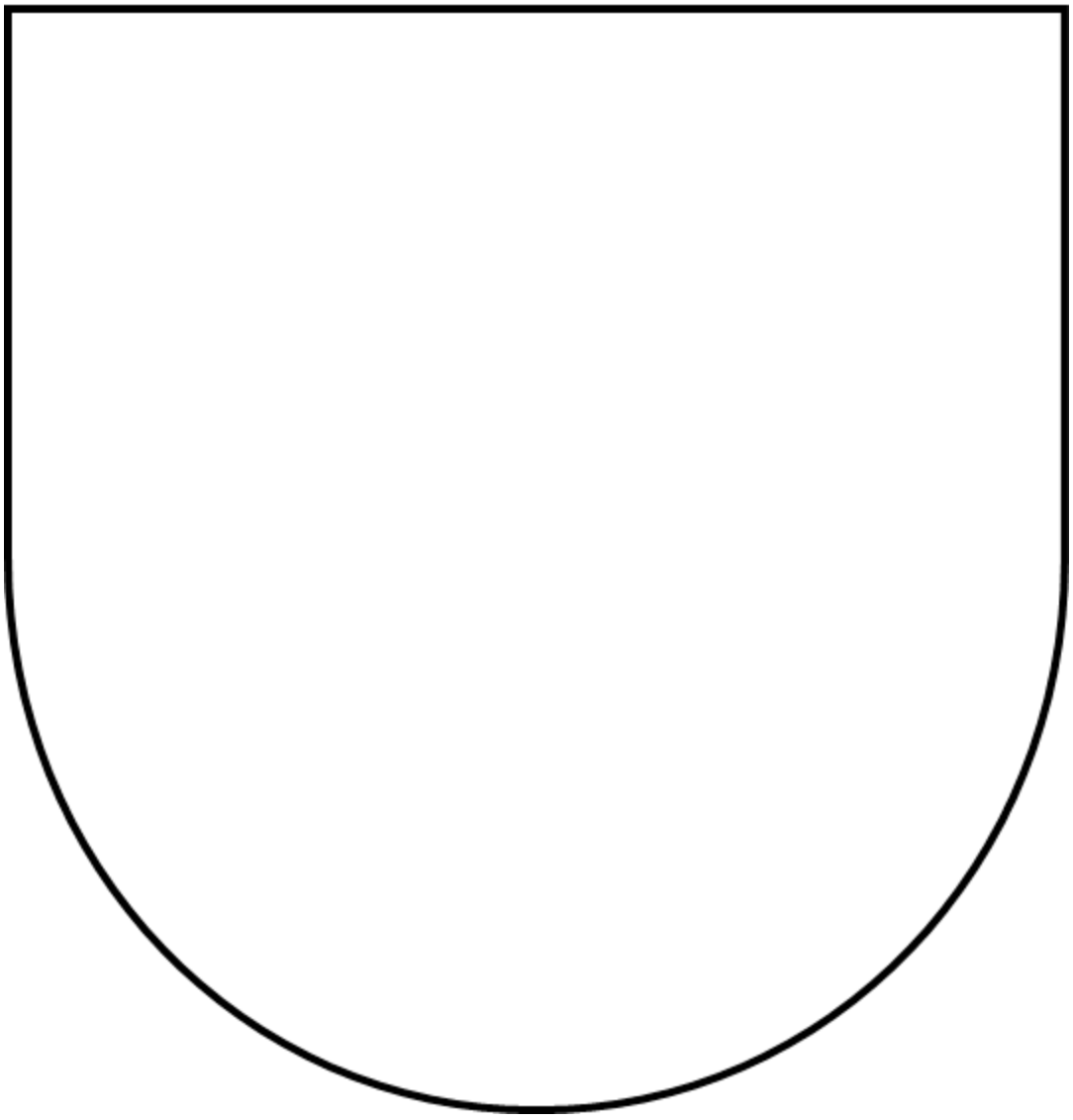
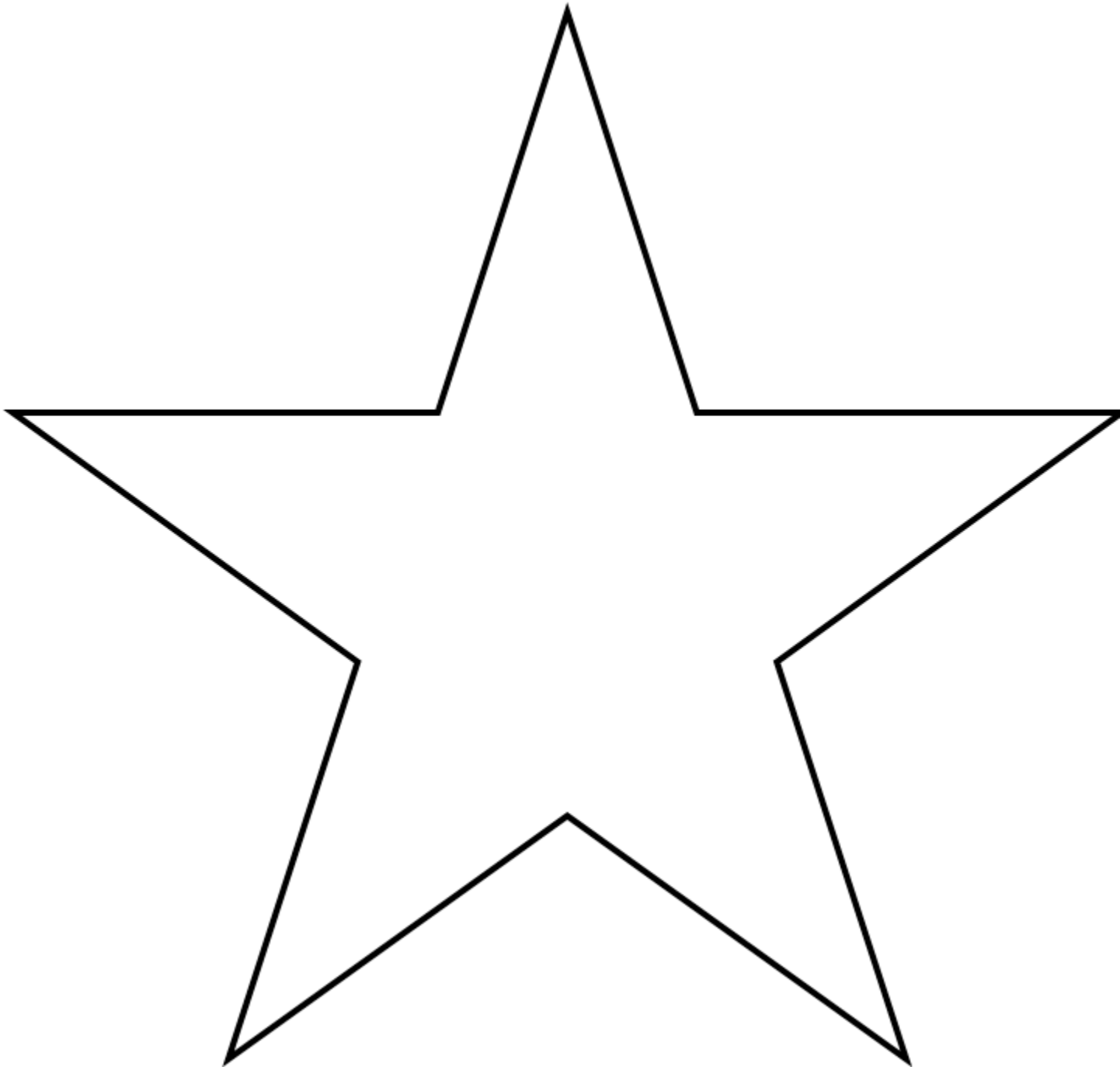


Logo Template



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. There are several websites available with suggestions for physical activities. Activities include ideas like jumping jacks or running in place.

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 derby cars
- Video of race car derbies

Watch a video of children racing derby cars that they have made. Read a book or a kid friendly journal article about race car derbies and the design of these cars Have students write things they wonder about derby cars in their journals. Ask students what forces make a derby car move.

Lunch

Time: 30 minutes

Afternoon Huddle

Time: 5 minutes
Materials: None

I hope you enjoyed lunch and are ready to build a car and race it! Let's look at some push cars in action. Show the video from the Engage section of the Push Car Derby lesson. https://education.lego.com/en-us/lessons/bricq-motion-train-to-win/push-car-derby#engage

Wow, that looked fun. Are you ready to see if your team can build a car that can go the farthest?

Challenge 1 – Push Car Derby

Time: 50 minutes
Materials:

- BricQ Motion Essential sets
- Building Instruction
- Student journals
- Graph paper
- Colored tape
- Tape measures

Ask students to think about the video. Ask students questions like:

- What made the cards move fast or slow? (push strength, hills, friction)
- What would happen if the people let go their car? (It would keep rolling.)
- What can slow a car down? (brakes, friction)

Have teams build the Push Car model and the launcher. The directions begin on page 28 of Building Instructions A booklet. When students have completed the models, have teams place their launchers at the starting line (a piece of tape or line on the floor). Measuring tapes should be placed so they start with 0 at the edge of the launcher.

Ask students to create a table in their journals to show the results of 5 trials with the brake on and without the brake on. An example is shown below

Brake On	**Distance (cm)**	**Brake Off**	**Distance (cm)**
Trial 1		**Trial 1**	
Trial 2		**Trial 2**	
Trial 3		**Trial 3**	
Trial 4		**Trial 4**	

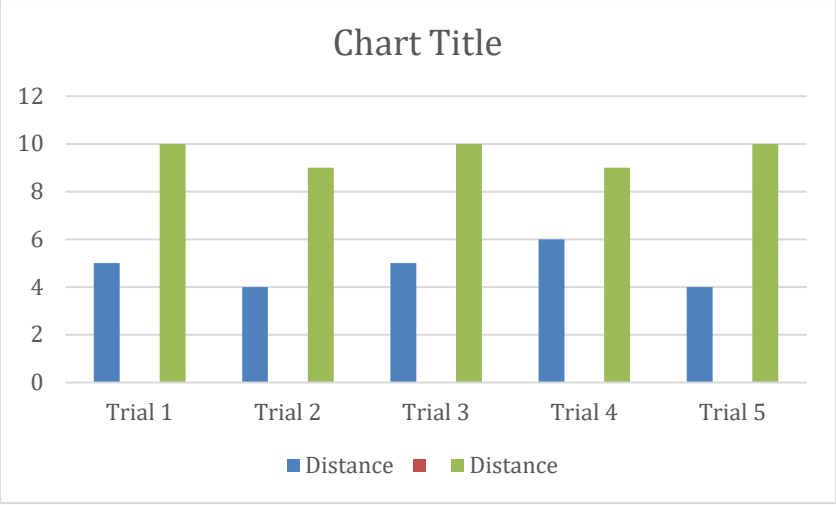
Trial 5		**Trial 5**	

Tell the students they will measure the distance traveled each time they launch their car. Give your students these instructions for the test challenge:

- The first trials will be with the yellow brake on.
- Push or pull the spring forward and hold it in place. Highlight that this retracts the spring and changes its shape.
- Place the car next to the Minifigure.
- Release the spring and watch the car go.
- Record the measurement in their journals.
- Each partner should have 5 trial runs. Record each trial's distance rolled.

> **Tip**: The car goes the farthest if you roll it back, so it's touching the yellow pushing brick before you let go of the spring. Demonstrate this to your students.

Ask students to create a graph comparing the distances traveled for each trial. An example is shown below:



Distance with Brake On – Blue
Distance with Brake Off - Green

Discuss the data. Ask questions, like:

- What did you notice about how the brake affected how far the car moved? Explain that the brake pushes against the wheel of the car and slows it down. The floor also pushes against the wheel. These forces are called "friction."
- Why do you think the car went farther in some of the trials than in others?

- What did you notice about pushing as a force?

Have students look at the arrows on the launcher.

- Why are there two arrows on the launcher?
- What are they indicating *(i.e., push/pull)*?

To further explain friction, have the students wave their hands in the air. Explain that it's easy because there's low friction. Then ask them to drag their hands across their desks. Explain that the harder they push down, the harder it is to move their hands. That's because there's high friction. The brake on a car works the same way.

Ask students to explain their findings. Have students write their conclusions in their journals.

Ask students to calculate the average distance the car traveled in the 10 trials (both partners) without the brake on. Write the average distance on their graph or in their table. Have students compare averages. Which team had the longest average distance traveled?

Ask students to take the models apart and place the elements in the correct locations.

Break

Time: 5 minutes

Challenge 2: Relay Race

Time: 60 minutes
Materials:

- BricQ Motion Essential sets
- Building Instruction
- Student journals
- Colored tape
- Tape measures

Show students the video from the Engage section of the Relay Race lesson.
https://education.lego.com/en-us/lessons/bricq-motion-train-to-win/relay-race#engage

Facilitate a discussion about what the students have learned about push and pull forces.

Ask questions, like:

- What models do you remember building?
- Which ones worked best for you?
- Would you like to build any of them again?

If the students need a little guidance, help them by asking:

- How can you use what you've learned about push and pull forces to make a relay race for the class?
- How can you move an object without touching it with your hands?
- What ideas do you have for a relay race?

Tell students they'll be using what they have already learned about push and pull forces to make a relay race for the class. Ask the students to choose an object to be used as the "baton" that's passed. This could be, for example, a LEGO® pizza element or a crumpled-up ball of paper.

Ask them to invent a mechanism that will enable them to pass the "baton" with a push or a pull, without touching it with their hands. Have them sketch their idea and then build it. Explain that they can use the models they have built in earlier lessons for inspiration or invent something new.

Allow students 25 minutes to sketch and build their models. Give students time checks so they know how much time is remaining. Teams need to test their models to ensure they work.

When the models are complete, gather the students together as a class. Ask questions like:

- How is your model pushing or pulling the "baton?"
- Which models inspired you?
- Which parts of your model are the same as your sketch? What's different?

Split the class into two teams. Decide on the racing order. Start the relay race with a 3-2-1 countdown. Each student will use their mechanism to pass their "baton" to the next student. If they drop their "baton," they can try again.

Have a big cheer to celebrate success when the "baton" reaches the finish line.

Every team should have 3 chances to race. Multiple teams can run at the same time **after** everyone has had a first trial. The focus is not how far they go but were they successful at passing the baton.

Ask students to write in their journals what was difficult and what was easy about this challenge and how they worked as partners to succeed.

Disassemble and Inventory Check

Time: 15 minutes
Materials:

- BricQ Motion Essential Sets

Ask students to take apart their models and return the pieces to the correct locations. Then, working with their partner, students will work to conduct an inventory check of the pieces in the yellow and gray and black tray areas to ensure all pieces are in the correct spots and no pieces are missing.

Daily Debrief and Wrap Up

Time: 20 minutes
Materials:

- Sticky notes

- Student journals
- Pencils
- Pens
- Markers

Have students use sticky notes to write down three things they really enjoyed about the day. Have students use a different sticky notes to write down one thing they are still wondering about. Place sticky notes in student journals.

Going the Distance Day 2

Balancing Act: Lifting Weights and Tight Rope Walking

Big Questions:

How do balanced and unbalanced forces affect objects?

Materials needed for the day:

- BricQ Motion Essential sets
- Chart paper
- Student journals
- Various craft materials
- Pens
- Pencils
- Markers

Outline of Day	Tasks	Time	Materials
9:00 - 9:50	Welcome	5 min	• Student journals
	Team Building Activity	15 min	• BricQ Motion Essential sets
	Review Group Rules Chart	5 min	• Group Rules Chart
	Morning Huddle	5 min	• None
	Readings and Wonderings .	20 min	• Book or journal article about gears used in machines
9:50 - 10:50	Challenge 1: Tightrope Walker	60 min	• BricQ Motion Essential sets Student journals
10:50 - 10:55	Break		
10:55 – 12:05	Workplace Wellness (physical activity)	15 min	• Varies, based on the activity selected

	Challenge 2: Tightrope Walker Word Problems	50 min	• BricQ Motion Essential sets Student journals
12:05 - 12:10	Get ready for lunch		
12:10 - 12:45	Lunch		
12:45 - 12:50	Team Briefing 3	5 min	• None
12:50 - 2:10	Challenge 3: Weightlifter	75 min	• BricQ Motion Essential sets Student journals
	Break	5 min	• None
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 in their journals from the previous day. Have students share their favorite moments from the previous day with a partner.

Team Building Activity

Time: 15 minutes
Materials:

- BricQ Motion Essential sets

Explain to students that each day will include some kind of 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 Strongest Tower

Provide each group with a container of loose LEGO® bricks. Have students work together to build the tallest tower they can that will hold the weight of an object. The object could be a water bottle, a dictionary, or a pack of sticky notes. The object needs to be given to each group and needs to be consistent.

At the end of the 5 minutes, encourage students to reflect on:

- 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?

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…)

Morning Huddle

Time: 5 minutes
Say to students:

> *Yesterday, you worked with push cars and relay races. Today, you will learn about balanced and unbalanced forces and mechanical advantage. You are going to build a tight rope walker. How will you ensure the walker does not fall?*

Readings and Wonderings

Time: 20 minutes
Materials:

- Videos on tightrope walkers
- Internet research on balanced and unbalanced forces
- Student journals

Show students some video footage or read a book about tightrope walking. Students should research tightrope walking. What forces do they have to keep in balance? What happens when the forces are out of balance?

Challenge 1: Tightrope Walker

Time: 60 minutes
Materials:

- BricQ Motion Essential sets
- Building Instruction A booklets
- Student journals
- Student worksheets One per team https://education.lego.com/v3/assets/blt293eea581807678a/bltd70a4f6418772098/5eabfb611b51e36d7c1b67c3/U1L5-worksheet.pdf

Show students the video from the Engage section of the Tightrope Walker lesson. https://education.lego.com/en-us/lessons/bricq-motion-train-to-win/tightrope-walker#engage

Facilitate a discussion about gravity. Ask questions, like:

- What's gravity? *(It's a force that pulls everything down to the ground.)*
- What's tightrope walking? *(The skill of walking along a thin wire or rope.)*
- What skill does a tightrope walker need in order to make sure they don't fall? *(Good balance.)*
- What is it that keeps a tightrope walker "up" on the tightrope? *(As long as they stay balanced on top of the rope, the rope pushes up on the walker's feet to keep them from falling off.)*

Ask the students to explore their center of gravity: Have them stand on 1 foot, with their other foot close to the ground. Tell them to start raising the foot that is not on the ground to see how long they can stand before losing their balance. Have them try this with their arms at their sides and then again with their arms open wide. Which is easier?

Ask students to stand on 1 foot with their other foot high off the ground. Then, have them try this while holding a book out to their side. Ask which way they felt the greatest pull of gravity and which way felt the most balanced.

Have the students work in pairs to build the Tightrope Walker model. When the students have finished building, introduce the test challenge.

Explain that the students will take turns testing the tightrope walker's center of gravity. They will slide the weighted bricks along the balance pole or add or remove bricks to either side of the pole to make the walker balanced or unbalanced.

Ask the students to draw on their Student Worksheets. They should note which bricks they have placed on each side of the tightrope walker’s pole, showing how they have made her balanced and unbalanced. Remind them to indicate whether the pole is longer or shorter on one side.

When teams have had time to do exploration and experimentation, gather the class together. Review and discuss the models. Ask questions, like:

- What did you notice about the tightrope walker's balance?
- How did the tightrope walker’s balance change when you moved the pole? Explain that gravity is the force that pulls the weighted bricks down the tightrope walker's arms or pole. This helps equalize the weight on both sides so she can maintain her center of gravity and not be pulled down, which would make her fall.

Break

Time: 5 minutes

Workplace Wellness: Physical Fitness

Time: 15 minutes
Materials:

- May vary depending on what activity is selected

Take a minute to complete a short physical activity. Ideas can be found on many internet sites. Simple exercises like jumping jacks or running in place can be used. Consider having students move like a walking robot to prepare them for the next challenge.

Challenge 2: Tightrope Walker Word Problems

Time: 50 minutes
Materials:

- BricQ Motion Essential sets
- Building Instruction A booklets
- Student journals

Ask teams to write 5 word problems about balancing the tightrope walker. Tell students the following:

- Use the model to help you decide what to ask and to check the answers.
- You can write problems about equalities and inequalities.
- Equalities would be where the forces are balanced and inequalities would be where the forces are unbalanced.
- You may wish to have the tightrope walk tilt to one side or the other.
- Think about the bricks you have in the set and how you could attach them.

When 30 minutes remain in the class, pair teams. Let each team see if they can solve the other team's word problems.

Have students take apart the models and return the pieces to the correct locations.

Lunch

Time: 30 minutes

Afternoon Huddle

Time: 5 minutes
Materials: None

Say to students:
I hope you enjoyed lunch and have enough energy to lift some weights. Are you tough enough? Well, actually you are going to build a weightlifter who will be doing the

physical work. You will have to do all the computational thinking. You mind will be stronger by the end of the day!

Challenge 3: Weightlifter

Time: 80 minutes (Take a 5 minute break in the middle of the lesson.)
Materials:

- BricQ Motion Essential sets
- Building Instruction B booklets
- Student journals

Show students the video from the Engage section of the Weightlifter lesson.
https://education.lego.com/en-us/lessons/bricq-motion-winning-with-science/weightlifter#engage

Facilitate a quick discussion about which forces the students have seen in the different types of weightlifting in the video. Ask questions like:

- Which forces help a weightlifter lift the weights? (Muscles pull to move our bodies, and they push or pull to lift and lower weights.)
- Which force makes the weights come back down? (Gravity)
- What's a pulley, and what's a block and tackle? How can these help a weightlifter train? (Pulleys are wheels that a rope or cable rolls over. A block and tackle is a system of two or more pulleys with a rope or cable threaded between them that can achieve a mechanical advantage in pulling a load.)

Have the students build the Weightlifter model. The directions start on page 68 of Building Instruction B booklet.

> **Note:** Building steps 21-29 can be challenging for students. In these steps, they'll start to incorporate more LEGO Technic elements into their building, and demonstrate their observational skills to route the string correctly. Use the reference model that you have prebuilt to help students self-identify any building errors.

Experiment 1

When students have completed the build have the teams test the model using pulley position 1 from the building instructions to raise the barbell.

Tell them to record their observations in their Student Journals. (This model has no mechanical advantage because it doesn't generate an increase or reduction of needed effort or speed. It only changes the direction of the motion.) The model isn't "strong enough" in this configuration to lift the barbell with all 4 weights *(wheels)* on. It can only lift with fewer wheels.

Ask the students to remove one wheel from the barbell. Record what happens with three wheels as barbells. Repeat the experiment 2 and then 1 wheel and record what happens. Have each partner complete the tests to verify what happens at each trial.

Discuss the trials. Ask questions like:

- When was the force acting on the weightlifter balanced or unbalanced? (The force was balanced when the model did not move and it was unbalanced when the weights pushed/pulled up and down or you used your hand.)

Experiment 2

Show the students how to change the model to pulley position 2. Have them test the model in this position and record their observations in their student journals. Ask students to repeat the test of 4, 3, 2, and 1 wheel as a bar bell.

Gather your students together to review and discuss their experiments. Ask questions like:

- What did you notice about the motion of the weightlifter when you changed the string position? (It was easier to move the weight, it moved by itself, and it didn't move as high.)

- What makes the weightlifter raise the weights? (The weight [i.e., the force of gravity] pulls down on the weighted bricks, and the pulleys convert that downward motion into an upward pull.)
- Why does pulley position 2 have a different result from pulley position 1? (Position 2 gives the model a mechanical advantage of 2 to 1. This means that the model halves the effort needed to lift the load but also halves the height to which the load is lifted. You would need to pull twice the length of string to lift the load the same height as pulley position 1.)

Experiment 3

Have students set up the Weightlifter model using pulley position 1 with the weight module lifted as high as it can go. The model will stay balanced. Have the students calculate how many wheels they would need to remove to allow the weightlifter to rise, and weight to fall (i.e., unbalanced force).

> **Note:** The pulleys' alignment and the force of friction on the pulleys will have a slight effect on the weights, so the weight of each side will vary.

These are the weights for each part of the Weightlifter model:

- Weight module 121 g
- Weightlifter 40 g
- Wheels 23 g (each)

Ask students to explain how the weights above affect the movement of the weightlifter.

Have each student create two word problems that show at one balanced and unbalanced force equation based on the weightlifter.

Change the Weightlifter model to pulley position 2. Remind students that mechanical advantage is at work now. Ask students what the mechanical advantage of the model was when they tested it previously.

Have each student create two word problems that show at one balanced and unbalanced force equation based on the weightlifter. Pair teams and have students share their word problems. Have the students solve another team's word problems.

Allow time for the students to disassemble their models, sort the bricks back into the trays, and clean up their workstations.

Cleanup, Daily Debrief, and Wrap Up

Time: 20 minutes
Materials:

- Student journals
- Markers
- Colored pencils
- Crayons

Ask students what was the easiest activity they did today. Ask students what was the most challenging activity they did today. Tell students they have worked their brains and have done a great job.

Have students write one word or phrase that they feel reflects what they have learned today. Write and illustrate the word in their student journals. Share their journal entry with two other people besides their partner.

Going the Distance Day 3

Going Down: Race Car and Gravity Race

Big Question:

Materials needed for the day:

- BricQ Motion Essential sets
- Building Instruction booklets
- Chart paper
- Student journals
- Various craft materials
- Pens
- Pencils
- Markers

Outline to Day	Tasks	Time	Materials
9:00 - 10:40	Welcome	5 min	• Student journals
	Team building activity	10 min	• BricQ Motion Essential sets •
	Review Group Rules Chart	5 min	• Group Rules Chart
	Morning Huddle	5 min	• None
	Readings and Wonderings	15 min	• Internet research • Student journals
	Challenge 1: Race Car	60 min	• BricQ Motion Essential sets • Building Instruction booklets • Student journals • Containers • Various craft materials

10:40 - 10:45	Break		
10:45 - 11:25	Challenge 1 continued	40 min	• BricQ Motion Essential 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
	Afternoon Huddle	5 min	• None
	Challenge 2: Gravity Car Derby	60 min	• BricQ Motion Essential sets • Building Instruction booklets • Student journals •
1:15 – 1:20	Break	5 min	
1:20 – 2:10	Challenge 3: Ramp Jumper	50 min	
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 share their word they create the day before with a neighbor. Compile a list of the words as a group. You can create a word cloud to share on the last day of the program.

Team Building Activity

Time: 10 minutes
Materials:

- Sets of identical LEGO® bricks from the BricQ Motion Essential sets
  (Each student needs the following: 1 yellow 2x4 bricks, 1 red 2x4 bricks, 1 lime green 2x4 plate, 1 red 2x4 plate, 1 lime green 1x4 technic brick, 1 2x3 blue plate)

Pair students together. Designate one student as Designer and one student as Builder.

Back-to-Back

Students will sit back to back. The designer will build something using the bricks they have without letting their partner see. When the build is complete, the Designer will communicate to the Builder the steps to create the exact same build without looking at them. The Builder may not ask questions. The Builder may say “Repeat, please” if needed. The goal is for the students to have the same build. After the team completes, they should compare models to see if they match exactly.

Have students change roles and try again.

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…)

Morning Huddle

Time: 5 minutes
Materials: None

> *Good Morning! Are you ready to race today? You will be creating race cars and seeing how can go the farthest. Get your Team ready as the pit crew because you will be changing tires.*

Research and Wonderings

Time: 15 minutes
Materials:

- Student journals

Discuss with students friction. Have students research how friction affects a race car. You may want to tell them that friction affects more than tires. They will be focused on the friction of tires rather than air today. Be sure that students understand friction is necessary for cars to move as well as to stop. Ask students how gravity affects the movement of a vehicle.

Challenge 1: Race Car

Time: 45 minutes
Materials:

- BricQ Motion Essential sets
- Building Instruction booklets
- Student journals
- Tape
- Measuring tape

Show students the video from the Engage section of the Race Car lesson. https://education.lego.com/en-us/lessons/bricq-motion-winning-with-science/race-car#engage

Facilitate a quick discussion about which forces the students have seen in action as they watched the car race in the video. Ask questions like:

- Which force makes a race car move? (The reaction force or thrust acts on the car's wheels to make them move. This comes from the motor or something else that's pushing the car forward.)
- Which force makes the race car stop? (The force of friction takes energy away from the car to slow it down as it rolls on its wheels. This is called "rolling resistance.")
- What can make the car go faster or slower? (Reducing mass and surface friction will help make the car go faster. Increasing mass and surface friction will slow it down.)

Tell students that they'll be building a race car model and launcher, then experiment to recognize a pattern in the car's motion. Have students build the race car model and launcher that begins on page 4 of Building Instruction B booklet and complete through page 18. When the models are complete, tell the students that they need to create a table in their student journals. They will need 4 columns (3 trials) and 5 rows (4 variables). Tell students they will be writing more than distance in each open space, so they need room enough for 5 distances.

An example is shown below:

Variable	Launcher Location 1	Launcher Location 5	Launcher Location 8
Small tires with gray hubs			
Medium tires with yellow hubs			
Large tires with white hubs			
Weight brick with large tires with white hubs			

Have students place a measuring tape on the floor or table and have 0 at the location where the launcher will stop extending. The car should not roll over the measuring tape, but rather roll beside it.

Experiment 1

Have students begin with the medium-sized tires with yellow hubs shown on page 18. Tell them to pull the launcher to position 1 and then let go. Each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Tell them to pull the launcher to position 5 and then let go. Ask the students to predict how far the car will travel before starting the trials. Each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Tell them to pull the launcher to position 8 and then let go. Ask the students to predict how far the car will travel before starting the trials. Each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Experiment 2

When the trials with the medium-sized wheels are complete, have students change the tires to the small wheels with the gray hubs located in the tray compartment holding gray and black pieces. Ask the students to predict how far the car will travel before starting the trials. Tell them to pull the launcher to position 1 and then let go. Tell teams that each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Tell them to pull the launcher to position 5 and then let go. Ask the students to predict how far the car will travel before starting the trials. Each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Tell them to pull the launcher to position 8 and then let go. Ask the students to predict how far the car will travel before starting the trials. Each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Experiment 3

When the trials with the medium-sized tires are complete, have students change the tires to the large tires with white hubs. Ask the students to predict how far the car will travel before starting the trials. Write the prediction in their journals. Tell them to pull the launcher to position 1 and then let go. Tell teams that each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Tell them to pull the launcher to position 5 and then let go. Ask the students to predict how far the car will travel before starting the trials. Write the prediction in their journals. Each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Tell them to pull the launcher to position 8 and then let go. Ask the students to predict how far the car will travel before starting the trials. Each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Break

Time: 5 minutes

Challenge 1: Continued

Time: 40 minutes
Materials:

- BricQ Motion Essential sets
- Building Instruction booklets
- Student journals
- Tape
- Measuring tape

Discuss with the class the experiments and their findings. Ask questions like:

- What did you observe when you tried the different wheels? (The smaller wheels traveled less distance than the larger wheels. This is because the smaller wheels rotate on the axle faster than the bigger wheels, which creates more friction).
- How can you make your car go as far as possible? (Answers should include pulling spring back all the way back, reducing weight, using the larger wheels, and launching the car on a smooth surface.)

Experiment 4

Ask students to be sure they are using the large tires on the car. Have students add the weight brick to the car. Ask students to predict how adding weight will affect the distance the car moves. Write the prediction in their journals. Tell them to pull the launcher to position 1 and then let go. Tell teams that each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Tell them to pull the launcher to position 5 and then let go. Ask the students to predict how far the car will travel before starting the trials. Write the prediction in their journals. Each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Tell them to pull the launcher to position 8 and then let go. Ask the students to predict how far the car will travel before starting the trials. Write the prediction in their journals. Each partner should use the launcher and test the car 5 times writing the distance the car traveled on the table in their journal.

Have students graph the longest distance for each trial using the large tires with white hubs for launcher positions 1, 5, and 8 with and without the weight bricks. Ask students to compare the distances on the graph and explain their findings. Have students write their conclusions in their journals.

Ask students to take apart the models and return the pieces to the correct locations in the set.

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. Ideas include standing on one foot and hopping, balancing an object on your head and bumping elbows with 5 different people. Other ideas can be found on the internet.

Afternoon Huddle

Time: 5 minutes
Materials: Optional – video of a soap box derby race.

> *Welcome back from lunch and a workout! You are ready for the next challenge. You did a great job with your car race so let's use gravity to help us win the derby. Gravity will pull your car to the finish line. Get ready, get set, and go learn about gravity and friction.*
>
> Optional: Show students a video of a soap box derby race.

Challenge 3: Gravity Car Derby

Time: 60 minutes
Materials:

- BricQ Motion Essential sets
- Building Instruction booklets
- Student journals
- Tape
- Measuring tape

Show students the video from the Engage section of the Gravity Car Derby lesson. https://education.lego.com/en-us/lessons/bricq-motion-winning-with-science/gravity-car-derby#engage

Facilitate a quick discussion about the forces that are at work in a downhill go-cart or soapbox car race. Ask questions like:

- What's a soapbox car race? (It is a downhill car race using a car without an engine.)
- Have you watched one on TV?
- Which force makes the car roll down the hill? (Gravity)
- Which force makes the car slow down? (Friction)
- What do you think gives winning cars a competitive advantage?

Tell the students that they are going to build a ramp and a gravity-powered car, and then experiment to recognize a pattern in the car's motion. Have the students work in pairs to build the Gravity Car Derby model. The directions begin on page 88 of the Building Instructions B booklet.

When the models are complete, place a measuring tape so that 0 is at the bottom of the ramp. Have the students place the car chassis without wheels at the top of the ramp, let it go, and observe what happens (they might need to give it a little push). Each partner should try it 3 times.

Ask students to share and explain their findings.

Now ask the students to design and build their own simple car model. Direct them to:

- Include a safety device to keep the Minifigure driver in the slippery seat. You cannot win the race if you fall out before the finish line!
- Use a brick to mark where they predict their car will stop after they let it go from the top of the ramp, measure the predicted distance, and record it in their student journals.
- Create a table in their journals to record their findings. An example is shown below.

Vehicle change	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
1st vehicle					
(Ex. Used larger tires)					
(Ex. Added weight brick)					
(Ex. Changed design)					

Have each partner test their first vehicle 5 times. Tell students to measure the actual distance it traveled, and record it in their journals.

When teams have completed the experiment with their first vehicle, tell them to change **one variable.** Explain that they can change the wheels OR add a weight brick OR change the design of the car. Only one variable at a time. Ask each team to decide the variable they will change and write it in their journal. Then, have students make that one

change and test their new vehicle. Tell teams that each partner should make 5 trials with the new vehicle, recording the distance of each fair trial.

When teams have completed the experiment with their second vehicle, tell them to change **one variable.** Explain that they can change the wheels OR add a weight brick OR change the design of the car. Only one variable at a time. Ask each team to decide the variable they will change and write it in their journal. Then, have students make that one change and test their new vehicle. Tell teams that each partner should make 5 trials with the new vehicle, recording the distance of each fair trial.

As a class, share and discuss the teams' findings. Ask questions like:

- How did the car move down the ramp without wheels? (It slid down the ramp at a constant speed, which was controlled by the friction between the car and the ramp.)
- Sometimes, the driver falls out of the car when it suddenly stops. Why does the driver keep moving even when the car has stopped? (This force is called "inertia." It can be explained by Newton's first law of motion, which states that an object in motion will stay in motion in the same direction and speed until other forces act upon it.)
- What difference did it make when you attached larger wheels to your car? (less rolling resistance friction, heavier car/more mass)

Ask teams to show to the class their design that traveled the longest distance. Ask students if they have some new ideas to test. Then tell students that they can build a new design and test it. Have students describe their new vehicle in their journals before they give it a fair test by both partners. Have students write their measurements in their journals.

Break

Time: 5 minutes

Challenge 3: Ramp Jumper

Time: 50 minutes
Materials:

- BricQ Motion Essential sets
- Building Instruction booklets
- Student journals
- Tape
- Measuring tape

Have students raise the small ramp at the bottom of the large ramp into a jump. Students may need to place some bricks under the small ramp to support it. Have students test their new design with the jump and see how it changes the behavior of their vehicle.

Have students create a table in their journals to record their findings. An example is shown below.

Vehicle change	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
1st vehicle					
(Ex. Used larger tires)					
(Ex. Added weight brick)					
(Ex. Changed design)					

Have each partner test their first vehicle 5 times. Tell students to measure the actual distance it traveled, and record it in their journals. Students may need to add comments on the way the vehicle behaved when it encountered the jump.

When teams have completed the experiment with their first vehicle, tell them to change **one variable.** Explain that they can change the wheels OR add a weight brick OR change the design of the car. Only one variable at a time. Ask each team to decide the

variable they will change and write it in their journal. Then, have students make that one change and test their new vehicle. Tell teams that each partner should make 5 trials with the new vehicle, recording the distance of each fair trial.

When teams have completed the experiment with their second vehicle, tell them to change **one variable.** Explain that they can change the wheels OR add a weight brick OR change the design of the car. Only one variable at a time. Ask each team to decide the variable they will change and write it in their journal. Then, have students make that one change and test their new vehicle. Tell teams that each partner should make 5 trials with the new vehicle, recording the distance of each fair trial.

Have students take apart their models and place the pieces correctly into the trays.

Daily Debrief and Wrap Up

Time: 20 minutes
Materials:

- BricQ Motion Essential sets
- Student journals

If optional activity was used, ask students how the jump affected their vehicle's behavior. Ask students what they would like to try next.

Have students use LEGO® elements to build a model that represents two things they learned today. Sketch their model and write the two things they learned today in their journals. Have students what activity they enjoyed the most today and have them write it in their journal.

Going the Distance Day 4

A New Olympic Event: Dancers and Create Your Own Olympic Event

Big Question:

What are different ways you can make a mechanism move?

Materials needed for the day:

- BricQ Motion Essential sets
- Building Instruction booklets
- BricQ Motion Essential Personal Learning Kits one per student
- Student journals
- Tape
- Measuring tape

Outline for Day	Tasks	Time	Materials
9:00 - 10:40	Welcome	5 min	• Student journals
	Team Building Activity	15 min	• BricQ Motion Essential sets
	Review Group Rules Chart	5 min	• Group Rules Chart
	Morning Huddle	5 min	• None
	Research and Wonderings	20 min	• Discussion • Internet research • Student journals
	Challenge 1: Dancers	50 min	• BricQ Motion Essential sets • Student journals
10:40 - 10:45	Break		

10:45 - 11:25	Challenge 2: Cheering Crowd continued	40 min	None
10:25 - 11:40	Complete Inventory of the Set* **If Personal Learning Kits are not being used,** move this complete inventory to the Clean up and Debrief section at the end.	20 min	• BricQ Motion Essential sets • Student journals
11:40 – 11:50	Workplace Wellness (physical activity)	10 min	• Varies, based on the activity selected
11:50 – 11:55	Get ready for lunch		
11:55 - 12:25	Lunch		
12:25 - 2:00	Afternoon Huddle	5 min	• None
	Challenge 3 Culminating Activity: Build Your Own Olympic Game	50 min	• BricQ Motion Essential Personal Learning Kits • Student journals
	Show Case: Let the Games Begin	50 min	• BricQ Motion Essential Personal Learning Kits • Student journals
2:00 - 2:30	Clean Up Daily Debrief and Wrap Up Celebration	20 min	• BricQ Motion Essential Personal Learning Kits • Student journals • Certificates

Welcome

Time: 5 minutes
Materials:

- Student journals

Welcome students back!. Have each student share their models from Day 3 debrief with a friend as a way to review what they had learned yesterday.

Team Building Activity

Time: 15 minutes
Materials:

- BricQ Motion Essential sets

Build Something That

- Work in groups of 4-5.
- Place the bricks in front of you.
- The teacher will name a category and your group will build 2-3 items that belongs in this category.
- When done building, please explain why this item belongs in the category.

Build something that:

- *can fly*
- *is an animal*
- *can be used for transportation*
- *you can have for lunch or dinner*

Tip: Ideas for other categories include a movie, cartoon characters, buildings, and so forth.

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 3 (times when students helped each other, asking great questions, teamwork, helping to clean up…)

Morning Huddle

Time: 5 min
Materials: None

Today you will begin with the support of a group of dancers. Where are they you might ask. You get to design and build the dancers that will be performing at the Olympic games. Later today you will be designing a new Olympic game.

Research and Wonderings

Time: 20 minutes
Materials:

- Discussion and Internet research
- Student journals

Have students research the summer Olympic games. They should find out what games are being played and what force and motion is required in one of the games they discovered. Have students present their findings to the class.

Challenge 1: Dancers

Time: 50 minutes
Materials:

- BricQ Motion Essential sets
- Student journals

Show students the video from the engage section of the Cheering Crowd lesson. https://education.lego.com/en-us/lessons/bricq-motion-winning-with-science/cheering-crowd#engage

Then, show students the video from the engage section of the Get Up and Dance lesson. Get Up and Dance (lego.com)

Facilitate a quick discussion about what your students observed in the videos.

Ask questions like:

- How were the people moving? (jumping, waving, giving a high five)
- What mechanisms did you see used?
- How do mechanisms imitate human movements?

Discuss with students what symmetry is and how that could be applied to people movements.

Ask for students to stand up and have half the class turn right and half the class turn left. Discuss other ways that symmetry could be used dividing the class into fourths.

Ask the students to work in groups of two teams to invent mechanisms that represents a dancing group of people. The models must work in sync with each other so all the dancers are symmetrical.

Tell students that they need to explain how their mechanisms make the dancers show symmetry and what fraction of the dancers are moving together. Ask the students to discuss and sketch their ideas before they start building. Tell them that they can ask their partner or others in the class for help if they get stuck.

> **Note:** If any of your students get stuck, help them by asking open-ended questions, like:
>
> - What's your idea?
> - What have you already tried?
> - What could you try next?
> - Where do you want a line of symmetry?
> - How many of the dancers are working together in a group?

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. Foster their creativity, explaining that many designers take time away from a project to rethink and revise their plans.

Break

Time: 5 minutes

Challenge 1: Continued

Time: 40 minutes
Materials:

- BricQ Motion Essential sets
- Student journals

Gather your students together to review and discuss what they have built.

Ask questions, like:

- Which models inspired you?
- Which parts of your model are the same as your sketch? What's different?
- How does your model move? What force(s) does it use?
- What ideas from other classmates do you like?

Now that they have seen a lot of other models, have students redesign their model. Tell them how much time remains in the class and give them a 10-minute time check so they can finish building. Bring everyone together when 5 minutes remain and have everyone show off their updated models.

Inventory Check*

***If your students are not using the Personal Learning Sets for the Culminating Activity,** then you should move the inventory check to Cleanup and Debrief section and allow extra time there.
Time: 20 minutes
Materials:

- BricQ Motion Essential sets

Ask student to take apart their models and return the pieces to the correct locations. Tell students to do a complete inventory of the set to confirm that all elements in the bin are present and in the correct tray compartments. You may wish to set up a system where each partner inventories one tray and they both inventory the pieces in the bottom of the bin.

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. Ideas can be found on several internet sites. You may wish for students to pretend to be a machine. Have students stand in a circle with arms out from their sides. Have them act in a wave where a hand touch causes the person to move their arm in an arc and touch the next persons hand. You can chose a start or start it yourself and continue to start at different intervals.

Lunch

Time: 30 minutes

Afternoon Huddle

Time: 5 min
Materials: None

> *This afternoon you will create a new Olympic game. You will use the pieces from the Personal Learning Kit which you will be taking home at the end of the day. Each person should create their own game, but you can ask others for help if you get stuck.*
>
> **Note:** If your students are not using the Personal Learning kits then they will be using the BricQ Motion Essential sets.

Culminating Project: Design a New Olympic Game

Time: 50 minutes
Materials:

- BricQ Motion Essential Personal Learning kits
- Student journals

Note: If your students are not using the Personal Learning kits then they will be using the BricQ Motion Essential sets.

Give each student a Personal Learning Kit. Tell students they are to create a new Olympic Game using the pieces from the kit. The game must have at least one push or pull ask an action.

Have students work in groups of 4 and allow 7 minutes for brainstorming. Give each group a piece of chart paper and 4 markers. Have them discuss and write all their ideas.

Put students into teams. Each team should discuss the ideas that appealed to the partners and start formulating one idea for a game. They should take notes in their journals of what they like and what they do not like or want to do.

Tell them they will need to name the game, write the directions for how to play the game and score points in their journals. Tell students that everyone will get to play the games after they are completed so they need to have their models and rules ready before the showcase.

Showcase: Olympic Games

Time: 50 minutes
Materials:

- BricQ Motion Essential Personal Learning kits
- Student journals
- Small shoeboxes or plastic containers

Have half the students stay in their current location and the other half will travel with their games. Determine a rotation for the traveling students. The traveling student will take their game with them and trade it with the students who are stationary. They play each other's game. Then, when time is called, the traveling students take their game to the next location. Allow time for students to play the games, give them one minute to finish and pick up their game pieces and move to the next location. You may find it easier to have shoe boxes or small plastic containers for the traveling students to use to hold their game pieces as they move through the classroom.

Cleanup, Daily Debrief, Wrap Up and Celebrate

Time: 20 minutes
Materials:

- Student journals
- Certificates

Celebrate success. Give students Certificates of Completion.

Note: If the BricQ Motion Essential Personal Learning kits are not used, allow time for doing complete inventory check before celebrating success and giving certificates. We suggest 20 minutes be allowed to take apart models and do a complete inventory.

Have students write in their journals about their machines.