Overview
In the Race Car Design Challenge, Brownies design cars and race tracks, then carry out “fair tests” to learn how design affects speed. Brownies learn how to design and test a car — and how design affects speed.

Step One: Learn how design can affect speed.
Step Two: Design and build your race car.
Step Three: Design your racetrack (To be completed in Race Car Design Challenge 2).
Step Four: Conduct a fair test and record results (To be completed in Race Car Design Challenge 2).
Step Five: Share what you learned (To be completed in Race Car Design Challenge 2).

This meeting, Brownies explore the concepts of speed and friction before they design and build a race car out of GoldieBlox. Brownies complete Step One & Step Two of the Race Car Design Challenge badge.

Note to Volunteers:

Use the Talking Points (But Make Them Your Own): In each session, you’ll find suggested talking points under the heading “SAY.” Some volunteers, especially new ones, find it helpful to follow the script. Others use the talking points as a guide and deliver the information in their own words. Either way is just fine.

Be Prepared (It’s What Girl Scouts Do!): Each meeting includes a “Prepare Ahead” section that includes a materials list and what kind of set-up is required. Read it in advance so you have enough time to gather supplies and enlist help, if needed.

This badge requires the GoldieBlox Making Things Zoom kit. Each kit includes 6 sets of GoldieBlox parts for the badge, (i.e. you can create 6 of any Brownie Design Challenge badge from one kit). Inside the kit are six sets of GoldieBlox parts that allow girls to earn all 3 Brownie Design Challenge badges. Two to four girls can use each set. So if you have 12 girls, buy one kit per them to work in pairs. You can purchase the kit online from the Girl Scout Shop: http://www.girlscoutshop.com/

You will not be able to buy the correct kit from the GoldieBlox website or your council shop.
Use Girl Scouts’ Three Processes: Girl-led, learning by doing, cooperative learning — these three processes are the key to making sure Brownies have fun in Girl Scouts and keep coming back.

“Learning by doing” and “cooperative learning” are built into this Badge, thanks to the hands-on activities and tips. You'll also find specific “keep it girl-led” tips in the meeting plans. They'll help you create an experience where Brownies know they can make choices and have their voices heard.

Fail Fast. Succeed Sooner: That’s how engineers solve problems. In this badge, Brownies will learn about engineering through hands-on activities. They’ll learn to: Brainstorm ways to solve a problem, design prototypes, test them to see what does and doesn’t work, then improve their designs. To engineers, failure is a good thing because every time a design fails, you learn something and can make it better.

You can help Brownies think this way. When her prototype doesn’t work, ask questions like, “Why do you think it didn’t work? How can you change your design? Try again — that’s what engineers do!” This approach also keeps the activity girl-led and fun because Brownies are free to invent things without feeling the pressure to make them perfect.

Leave Time for the Closing Ceremony: If Brownies are having fun doing a Design Challenge, you may be tempted to skip the Closing Ceremony so they can keep going — but the Closing Ceremony is absolutely key to their learning. Here’s why:

When Brownies leave a meeting, they'll remember how much fun it was to build a Leap Bot or to make a car speed down a ramp. However, they may not realize that they just learned how engineers solve problems or that they’re good at engineering — unless you tell them.

That’s why the Closing Ceremony is so important. It’s where you can connect the dots for Brownies by:

- Pointing out how they acted as engineers. (For example: They did rapid prototyping. When one of their prototypes didn’t work, they saw that “failure” as helpful feedback and tried something else. They worked together to find solutions. They shared their designs and offered suggestions.)
- Reminding Brownies that they are already engineers — and that it’s fun to solve problems using engineering.
- Letting them know that they have what it takes to continue exploring STEM.
These simple messages can boost Brownies’ confidence and interest in STEM — and end the meeting on an upbeat note!

Tell Your Troop Story: As a Girl Scout leader, you’re designing experiences that Brownies will remember their whole lives. Try to capture those memories with photos or videos. Brownies love remembering all they did — and it’s a great way for parents to see how Girl Scouting helps their Brownies!

And please do share your photos and videos with GSUSA by emailing them to STEM@girlscouts.org (with photo releases if at all possible!).

Prepare Ahead (Roughly 50 minutes)

PLEASE NOTE: You will need the GoldieBlox Making Things Zoom kit for girls to complete the requirements and earn the badges. Details for the kit are listed in this section and on the Materials List.

1. Review vocabulary (2 minutes)

This meeting introduces a new word:

- **Force** – the strength or energy that creates movement. Push and pull are examples of force.
- **Friction** – a force that slows moving objects.
- **Features** – parts of a product that are designed make them more useful.

See the Glossary for Brownie Design Challenge Badges for more vocabulary and examples.

2. Read through this guide and handouts (15 minutes)

This will help you get familiar with the flow of the meeting.

The following handouts can be found in Meeting Aids.

- **Brownie Design Challenge Badges Materials List**: Each meeting has its own materials list, but you can use this handout if you like to do all your supply shopping at one time. It includes all materials needed for the entire badge.
• **Glossary for Brownie Design Challenge Badges:** This is a list of words that Brownies may not know and how to define them.

• **Think, Pair, Share:** These facilitation tips will help you to make sure that every girl’s voice is heard during brainstorming activities.

3. **Gather materials (30 minutes)**

Gather materials using the Materials List for this meeting. If your meeting location doesn’t have a flag, bring a small one that Brownies can take turns holding or hang in the room.

(Note to Volunteers: You will need the GoldieBlox Making Things Zoom kit for the girls to complete the requirements and earn the badges. You can purchase this from the Girl Scouts Shop: [http://www.girlscoutshop.com/](http://www.girlscoutshop.com/).

Get Help from Your Family and Friends Network

**Your Friends and Family Network can include:**
- Brownies’ parents, aunts, uncles, older siblings, cousins, and friends
- Other volunteers who have offered to help with the meeting.

**Ask your Network to help:**
- Bring art supplies.
- Assist with Design Challenge activities.

**Award Connection**

Brownies will earn one award:
- Race Car Design Challenge badge

Brownies receive the award following the completion of all three steps of the badge in **Race Car Design Challenge 2**.

(Note to Volunteers: You can buy these awards from your council shop or on the Girl Scouts’ website.)

**Meeting Length**

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90 minutes
- The times given for each activity will be different depending on how many Brownies are in your troop.
- There is no snack time scheduled in these meetings, but there are 15 minutes of “wiggle room” built in for snacks or activities that run long.
- Give Brownies 10- and 5-minute warnings before they need to wrap up the last activity so you’ll have time for the Closing Ceremony.

In the Race Car Design Challenge, Brownies design cars and race tracks, then carry out “fair tests” to learn how design affects speed. Brownies learn how to design and test a car — and how design affects speed.

**Step One:** Learn how design can affect speed.

**Step Two:** Design and build your race car.

**Step Three:** Design your racetrack (To be completed in Race Car Design Challenge 2).

**Step Four:** Conduct a fair test and record results (To be completed in Race Car Design Challenge 2).

**Step Five:** Share what you learned (To be completed in Race Car Design Challenge 2).

This meeting, Brownies explore the concepts of speed and friction before they design and build a race car out of GoldieBlox. Brownies complete Step One & Step Two of the Race Car Design Challenge badge.

**Materials List**

**Activity 1: As Girls Arrive: Playing with Force and Friction**
- Sports and game balls (one for each pair of girls). Bring different types of balls for girls to roll and observe friction. For example, you might bring a marble, tennis ball, basketball, ping pong ball, baseball, etc.
- Create two lines with masking tape on the floor. Each Brownie should sit on the line, facing their partner.

**Activity 2: Opening Ceremony: Engineering Speed**
- Flag
Optional: Poster Board with the Girl Scout Promise and Law

Activity 3: Learn How Design Can Affect Speed
- Toy car to demonstrate force and friction

Activity 4: Design and Build Your Race Car
- GoldieBlox Making Things Zoom kit (one set for each pair or small team.) Feel free to add additional pieces from personal GoldieBlox kits that you or your Girl Scouts may own.

Activity 5: Closing Ceremony: Share Your Design
- Race Cars built by Brownies in Activity 4: Design and Build Your Race Car

Awards
Girls do not receive any awards in this meeting.

Detailed Activity Plan

Activity 1: As Girls Arrive: Playing with Force and Friction

Time Allotment
10 Minutes

Materials
- Sports and game balls (one for each pair of girls). Bring different types of balls for girls to roll and observe friction. For example, you might bring a marble, tennis ball, basketball, ping pong ball, baseball, etc.
- Create two lines with masking tape on the floor. Each Brownie should sit on the line, facing their partner.

Steps
Prior to girls arriving, create two masking tape lines. The lines should be close enough that Brownies can roll a ball back and forth between them.

As Brownies arrive, welcome them, and have them pair up.

Hand each pair a ball, and have them sit facing each other on the lines and roll their ball back and forth.
Brownies can roll their ball a few times, then exchange it with another pair to try another.

**SAY:**
*Roll your ball back and forth with your partner.*

*What happens when you roll it lightly? Does it reach your partner?*

*What happens when you roll it with a lot of strength?*

Brownies roll their balls, experimenting with force.

**Activity 2: Opening Ceremony: Engineering Speed**

**Time Allotment**
10 Minutes

**Materials**
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

**Steps**
Recite the Pledge of Allegiance and the Promise and Law.

Conduct any troop business.

Introduce Brownies to the Race Car Design Challenge badge.

**SAY:**
*Today you’re going to be engineers as we start the Race Car Design Challenge!*  

You’ll design, build, and test race cars made from GoldieBlox. Next time, you’ll get to improve them based on your tests and race them down a race track!

**Activity 3: Learn How Design Can Affect Speed**

**Time Allotment**
15 Minutes
Materials
- Toy car to demonstrate force and friction

Steps

Brownies explore the concepts of speed and friction through a volunteer demonstration for Step One of the Race Car Design Challenge.

Compare how the different balls rolled in Activity 1: As Girls Arrive: Playing with Force and Friction as examples of force.

**SAY:**

*Let’s get started and learn something important engineers have to think about when they build things.*

*When you were rolling your balls earlier, what made the balls move faster? (Answer: Rolling it with more strength or force.)*

*When you were rolling your balls earlier, what made the balls move slower? (Answer: Using less strength or force.)*

*Each time you rolled the ball, you changed the amount of force you used. Force is the amount of strength or energy it takes to move something.*

Explain friction to Brownies, using the different balls used in Activity 1: As Girls Arrive: Playing with Force and Friction.

**SAY:**

*Were there any balls that were easier or harder to roll? Why do you think that was?*

*Girls may say: It was hard to roll the tennis ball on the carpet, the ping pong ball went the fastest, etc.*

*Each of the balls is made of a different material and weighs a different amount.*

*For example, the smaller balls may have been easier to roll. Why do you think that is? (Answer: The smaller balls were lighter, so the surface affected it less as it moved.)*
When you roll the ball, there is something called friction that stops the ball.

Friction is a force that slows and stops moving objects. Without friction, any object that was pushed or pulled would keep moving forever!

For example, if there wasn’t friction on the road, a car would keep moving forward forever, crashing into other things.

Demonstrate how a car is moved by force and speed, and how the wheels against the road create friction.

**SAY:**

Why do cars have wheels?

**Girls may say:** To help it to move, etc.

Cars have wheels that turn to push the car forward with force.

The toy car also moves because you push it with force, just like the balls moved before.

As the car moves, friction between the car’s wheels and the road slow it down so that it doesn’t keep going forward forever.

Designing a car with wheels allows the car to move with more force and less friction. Wheels reduce the amount of the space touching the ground, allowing the car to move with more ease.

Hold up the car, and ask girls what they could do to the wheels or the race track to make the car go faster.

Spin the wheels and point out the axles. You might talk about reducing friction between the wheels and the track, reducing friction between the wheels and axles, reducing friction between the wheels and the body, keeping the car rolling straight, changing the center of gravity, etc.

**SAY:**

Race car designers add or create special features, parts of something, that help their car to go fast. Engineers create these features to make their products more useful.
Today, we’ll use GoldieBlox to design and build race cars! How can we use science to make a faster Race Car?

Activity 4: Design and Build Your Race Car

Time Allotment
25 Minutes

Materials
- GoldieBlox Making Things Zoom kit (one set for each pair or small team.) Feel free to add additional pieces from personal GoldieBlox kits that you or your Girl Scouts may own.

Steps
Divide Brownies into pairs or small groups to design and build their race car for Step Two of the Race Car Design Challenge.

Hand out paper and pencils to each team for Brownies to design their Race Car.

SAY:
Now, you’re going to use your GoldieBlox to create a Race Car.

Before engineers build things, they plan their design. Designing your product before you build allows you to think through any problems and troubleshoot them ahead of time.

Draw your Race Car to help figure out how to build it. Look at the pieces in the kit to see what fits together to create your car.

When they’re finished designing, hand out the GoldieBlox sets.

Let the girls build their Race Cars.

Keep It Girl-Led: By having girls reverse engineer a Race Car, Brownies have a hands-on opportunity to learn about the different parts instead of following directions. If they’re having trouble, ask them questions like, “What GoldieBlox should you put into your car? How do you attach the wheels?”

Circulate among the groups, asking questions to prompt further exploration.
(Note to Volunteers: You may want to save the Brownies’ Race Cars for the next meeting, Race Car Design Challenge 2. If you are able to, label each car with the girl or group’s name(s) and put away until the next meeting. If you are unable to keep them together, don’t worry, the girls will have a chance to rebuild at the start of the next meeting.)

If Brownies have extra time, they can practice pushing their cars around the room using different amounts of force.

Activity 5: Closing Ceremony: Share Your Design

Time Allotment
10 Minutes

Materials
- Race Cars built by Brownies in Activity 4: Design and Build Your Race Car

Steps

Have Brownies form a Friendship Circle, and have their share their race cars from Activity 4: Design and Build Your Race Car.

Each girl has a chance to share about her design decisions.

SAY:
How did you design your car?

What special features did you add to your car?

Did you improve the speed of your car? How?

How could you make your car go even faster?

End the meeting with a Friendship Squeeze.

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Brownies may not know some of the words used in these badges. Here are definitions you can share with them:

**Engineers** are people who like to know how things work. They design and build things people use every day, like computers, phones, roads, bridges and cars.

**Force** is the strength or energy that creates movement. Push and pull are examples of force.

**Gravity** is a force that pulls objects toward each other and towards the earth.

**Potential energy** is the energy stored in your body and everything else in our world.

When potential energy is released, it becomes **kinetic energy** which brings bodies and objects to move.

**Thrust** is a force that slows moving objects.

**Drag** is the force (air molecules) that acts against something in flight.

**Lift** is a force that pushes back up on the wings during flight.

**Balanced forces** exist when forces are equal on an object. When the forces are balanced, the object does not move.

**Unbalanced forces** exist when forces are unequal on an object. When the forces are unbalanced, it moves in the direction of the greater force.

**Features** are parts of a product that are designed to make them more useful.

**Friction** is a force that slows moving objects.
Brownie Design Challenge Badges: Materials List

Leap Bot Design Challenge 1

Activity 2: Opening Ceremony: All About Solving Problems
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

Activity 3: Learn About Springs
- Sample Leap Bot made from the GoldieBlox Making Things Zoom kit

Activity 4: Build Your Leap Bot
- GoldieBlox Making Things Zoom kit (one set for each pair or small team)
For each Leap Bot, girls will need these GoldieBlox:
- 4 mini axles
- 1 long axle
- 2 angle joints
- 2 elbow joints
- 4 spacers
- 4 pegs
- 1 star coupler
- 3 wheel hubs
- 3 small wheel ends
- 2 big wheel ends
- 1 long spring

Leap Bot Design Challenge 2

Activity 1: As Girls Arrive: Prepare For Testing
- Leap Bots created by girls in Leap Bots Design Challenge 1. (Note to Volunteers: If you were unable to save the Bots between meetings, Brownies can rebuild them during this activity.)
- Leftover pieces from the GoldieBlox Making Things Zoom kit (one set for each pair or small team).

Activity 2: Opening Ceremony: Leap Bot Forces
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

Activity 3: Create a Way to Test How Well Your Leap Bot Performs
- Leap Bots created by girls in Leap Bot Design Challenge 1 or Activity 1: As Girls Arrive: Prepare for Testing
- Rulers, yardsticks, etc.
- Tape
- Paper

Activity 4: Record the Results of Your Test
- Leap Bots created by girls in Leap Bot Design Challenge 1 or Activity 1: As Girls Arrive: Prepare for Testing
- Leap Bot Testing Stations created by girls in Activity 3: Create a Way to Test How Well Your Leap Bot Performs
- Leap Bot Recording Sheet
- Long and Short springs from the GoldieBlox Making Things Zoom kit (3 or more from each set for each pair or small team)
- Leftover pieces from the GoldieBlox Making Things Zoom kit (for each pair or small team)
Brownie Design Challenge Badges: Materials List

Leap Bot Design Challenge 2 (continued)

Activity 5: Share Your Results
• Leap Bot Recording Sheets, filled out by girls in Activity 4: Record the Results of Your Test

Activity 6: Closing Ceremony: Awards
• Leap Bot Design Challenge award

(Note to Volunteers: You can buy these awards from your council shop or on the Girl Scouts’ website.)

Fling Flyer Design Challenge 1

Activity 1: As Girls Arrive: Engineering Paper Airplanes
• Paper (Construction, white, etc. A variety of papers gives girls the opportunity to try making planes with different paper weights.)
• Crayons, colored markers

Activity 2: Opening Ceremony: Taking Flight!
• Flag
• Optional: Poster Board with the Girl Scout Promise and Law

Activity 3: Learn About the Forces that Affect Flight
• Paper Airplanes from Activity 1: As Girls Arrive: Engineering Paper Airplanes

Activity 4: Design and Build a Fling Flyer
• GoldieBlox Making Things Zoom kit (one set for each girl, pair, or small team)
• Sample Fling Flyer
• Paper
• Pencils
• Optional: Fling Flyer Investigation worksheets

For each Fling Flyer, girls will need these GoldieBlox:
• 2 mini axles
• 1 long axle
• 2 star stoppers
• 1 angle joint
• 2 T-joints
• 1 craftstruction wing (Alternatively, you can prepare or have girls create their own wings using cardstock, construction, or copy paper and scissors/paper hole push.)
• 1 rubber band
Brownie Design Challenge Badges: Materials List

Fling Flyer Design Challenge 2

**Activity 1: As Girls Arrive: Prepare for Testing**
- Fling Flyers created by girls in Fling Flyer Design Challenge 1. **(Note to Volunteers:** If you were unable to save the Flyers between meetings, Brownies can rebuild them during this activity.)

**Activity 2: Opening Ceremony: Forces that Affect Flight**
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

**Activity 3: Test Your Fling Flyer**
- Fling Flyers created by girls in Fling Flyer Design Challenge 1 or Activity 1: As Girls Arrive: Prepare for Testing
- Cardstock, construction paper, or copy paper (the heavier the better)
- Scissors or hole punches
- Leftover pieces from the GoldieBlox Making Things Zoom kit (one set for each pair or small team)
- Masking tape
- Cone, rock, or anything else to mark the furthest distance flown

**Activity 5: Brainstorm Ways to Improve Your Design**
- Fling Flyers from Activity 3: Test Your Fling Flyer
- Cardstock, construction paper, or copy paper (the heavier the better)
- Scissors or hole punches
- Leftover pieces from the GoldieBlox Making Things Zoom kit (one set for each pair or small team)

**Activity 6: Closing Ceremony: Awards**
- Fling Flyer Design Challenge award
  **(Note to Volunteers:** You can buy these awards from your council shop or on the Girl Scouts’ website.)

Race Car Design Challenge 1

**Activity 1: As Girls Arrive: Playing with Force and Friction**
- Sports and game balls (one for each pair of girls). Bring different types of balls for girls to roll and observe friction. For example, you might bring a marble, tennis ball, basketball, ping pong ball, baseball, etc.
- Create two lines with masking tape on the floor. Each Brownie should sit on the line, facing their partner.

**Activity 2: Opening Ceremony: Engineering Speed**
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

**Activity 3: Learn How Design Can Affect Speed**
- Toy car to demonstrate force and friction
Brownie Design Challenge Badges: Materials List

Race Car Design Challenge 1 (continued)

Activity 4: Design and Build Your Race Car
- GoldieBlox Making Things Zoom kit (one set for each pair or small team.) Feel free to add additional pieces from personal GoldieBlox kits that you or your Girl Scouts may own.

Activity 5: Closing Ceremony: Share Your Design
- Race Cars built by Brownies in Activity 4: Design and Build Your Race Car

Race Car Design Challenge 2

Activity 1: As Girls Arrive: Build A Simple Ramp
- Race cars created by girls in Race Car Design Challenge 1. (Note to Volunteers: If you were unable to save the race cars between meetings, Brownies can rebuild their cars during this activity.)
- Folders, poster boards, cardboard, etc., to lean against something to create a ramp
- Books, boxes, tables, etc. to create the height and top of a ramp

Activity 2: Opening Ceremony: Reviewing Force and Friction
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

Activity 3: Design Your Racetrack
- Poster boards, cardboard, etc., to lean against something to create ramps
- Table(s) or books to create the top of ramps
- Paper or newspaper
- Masking tape

Activity 4: Conduct a Fair Test and Record Results
- Yardstick
- Ramp created by girls in Activity 3: Design Your Racetrack
- Race cars created by girls in Race Car Design Challenge 1 or rebuilt in Activity 1: As Girls Arrive: Build a Simple Ramp
- Optional: Phone or camera to capture “photo finishes”

Activity 5: Share What You Learned
- Race cars redesigned by girls in Activity 4: Conduct a Fair Test and Record Results

Activity 6: Closing Ceremony: Awards
- Race Car Design Challenge award

(Note to Volunteers: You can buy these awards from your council shop or on the Girl Scouts’ website.)
Brainstorming Tips: Think, Pair, Share

How to Run a Think, Pair, Share Activity:

Tell girls that they’re going to brainstorm answers to your question using “Think, Pair, Share.”

Lead girls through the basic steps by telling them they will:

1. **Break into small groups.**

2. **Listen to the question or prompt.**

3. **Think about their answers.**
   - Girls may want to write their answers down.
   - Twenty seconds should be enough time, since girls will need to sit quietly.

4. **Pair with other girls.**
   - Girls talk with one to three other girls (depending on group size), making sure everyone has a chance to share their answers. If there’s time, it’s OK for girls to ask questions about each other’s answers.
   - For pairs, 20 seconds should be enough time. If your troop enjoys discussion, consider extending this to 1 to 2 minutes.

5. **Share with the group.**
   - Girls share their answers with the larger group.
   - This can be completed in 20 – 30 seconds, but will run longer based on group size and how the group sharing is done.

There are two ways to set up group sharing:

- **Strongly Recommended:** One girl shares the best/most interesting/summary answer for the group. This approach is great if you’re running short on time. It also helps develop conflict resolution and compromise skills.

- **Optional:** Each girl shares her partner’s answer. This helps girls develop active listening skills, but will run longer because all girls are sharing.
The Girl Scout Promise

On my honor, I will try:
To serve God and my country,
To help people at all times,
And to live by the Girl Scout Law.

The Girl Scout Law

I will do my best to be
honest and fair,
friendly and helpful,
considerate and caring,
courageous and strong, and
responsible for what I say and do,
and to
respect myself and others,
respect authority,
use resources wisely,
make the world a better place, and
be a sister to every Girl Scout.
Race Car Design Challenge badge

Spring Car

engineering concept:
SIMPLE MACHINES

build date:

I built it!

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Overview
In the Race Car Design Challenge, Brownies design cars and race tracks, then carry out “fair tests” to learn how design affects speed. Brownies learn how to design and test a car — and how design affects speed.

Step One: Learn how design can affect speed (completed in Race Car Design Challenge 1).
Step Two: Design and build your race car (completed in Race Car Design Challenge 1).
Step Three: Design your racetrack.
Step Four: Conduct a fair test and record results.
Step Five: Share what you learned.

This meeting, Brownies create a racetrack and conduct a fair test before sharing what they learned. Brownies complete Step Three, Step Four & Step Five, earning the Race Car Design Challenge badge.

Note to Volunteers:
Use the Talking Points (But Make Them Your Own): In each session, you’ll find suggested talking points under the heading “SAY.” Some volunteers, especially new ones, find it helpful to follow the script. Others use the talking points as a guide and deliver the information in their own words. Either way is just fine.

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You can help Brownies think this way. When her prototype doesn’t work, ask questions like, “Why do you think it didn’t work? How can you change your design? Try again—that’s what engineers do!” This approach also keeps the activity girl-led and fun because Brownies are free to invent things without feeling the pressure to make them perfect.

Leave Time for the Closing Ceremony: If Brownies are having fun doing a Design Challenge, you may be tempted to skip the Closing Ceremony so they can keep going—but the Closing Ceremony is absolutely key to their learning. Here’s why:

When Brownies leave a meeting, they’ll remember how much fun it was to build a Leap Bot or to make a car speed down a ramp. However, they may not realize that they just learned how engineers solve problems or that they’re good at engineering—unless you tell them.

That’s why the Closing Ceremony is so important. It’s where you can connect the dots for Brownies by:

- Pointing out how they acted as engineers. (For example: They did rapid prototyping. When one of their prototypes didn’t work, they saw that “failure” as helpful feedback and tried something else. They worked together to find solutions. They shared their designs and offered suggestions.)
- Reminding Brownies that they are already engineers—and that it’s fun to solve problems using engineering.
- Letting them know that they have what it takes to continue exploring STEM.
These simple messages can boost Brownies’ confidence and interest in STEM — and end the meeting on an upbeat note!

Tell Your Troop Story: As a Girl Scout leader, you’re designing experiences that Brownies will remember their whole lives. Try to capture those memories with photos or videos. Brownies love remembering all they did — and it’s a great way for parents to see how Girl Scouting helps their Brownies!

And please do share your photos and videos with GSUSA by emailing them to STEM@girlscouts.org (with photo releases if at all possible!).

Prepare Ahead (Roughly 50 minutes)

PLEASE NOTE: You will need the GoldieBlox Making Things Zoom kit for girls to complete the requirements and earn the badges. Details for the kit are listed in this section and on the Materials List.

1. Review vocabulary (2 minutes)

This meeting introduces a new word:

- **Force** – the strength or energy that creates movement. Push and pull are examples of force.
- **Friction** – a force that slows moving objects.
- **Features** – parts of a product that are designed make them more useful.
- **Gravity** – a force that pulls objects toward each other and towards the earth.
- **Fair test** – change only factor at a time while keeping all other conditions the same.
- **Failure point** – the specific part of a design or build that isn’t working.

See the Glossary for Brownie Design Challenge Badges for more vocabulary and examples.

2. Read through this guide and handouts (15 minutes)

This will help you get familiar with the flow of the meeting.
The following handouts can be found in Meeting Aids.

- **Brownie Design Challenge Badges Materials List**: Each meeting has its own materials list, but you can use this handout if you like to do all your supply shopping at one time. It includes all materials needed for the entire badge.

- **Glossary for Brownie Design Challenge Badges**: This is a list of words that Brownies may not know and how to define them.

- **Think, Pair, Share**: These facilitation tips will help you to make sure that every girl’s voice is heard during brainstorming activities.

3. **Gather materials (30 minutes)**

Gather materials using the Materials List for this meeting. If your meeting location doesn’t have a flag, bring a small one that Brownies can take turns holding or hang in the room.

(***Note to Volunteers**: You will need the GoldieBlox Making Things Zoom kit for the girls to complete the requirements and earn the badges. You can purchase this from the Girl Scouts Shop: [http://www.girlscoutshop.com/](http://www.girlscoutshop.com/).

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**Get Help from Your Family and Friends Network**

**Your Friends and Family Network can include:**

- Brownies’ parents, aunts, uncles, older siblings, cousins, and friends
- Other volunteers who have offered to help with the meeting

**Ask your Network to help:**

- Bring art supplies.
- Assist with Design Challenge activities.

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**Award Connection**

Brownies will earn one award:

- **Race Car Design Challenge badge**

Brownies receive the award following the completion of the final three steps of the badge this meeting.
Race Car Design Challenge 2

(Note to Volunteers: You can buy these awards from your council shop or on the Girl Scouts’ website.)

Meeting Length
90 minutes
- The times given for each activity will be different depending on how many Brownies are in your troop.
- There is no snack time scheduled in these meetings, but there are 15 minutes of “wiggle room” built in for snacks or activities that run long.
- Give Brownies 10- and 5-minute warnings before they need to wrap up the last activity so you’ll have time for the Closing Ceremony.

In the Race Car Design Challenge, Brownies design cars and race tracks, then carry out “fair tests” to learn how design affects speed. Brownies learn how to design and test a car — and how design affects speed.

Step One: Learn how design can affect speed (completed in Race Car Design Challenge 1).
Step Two: Design and build your race car (completed in Race Car Design Challenge 1).
Step Three: Design your racetrack.
Step Four: Conduct a fair test and record results.
Step Five: Share what you learned.

This meeting, Brownies create a racetrack and conduct a fair test before sharing what they learned. Brownies complete Step Three, Step Four & Step Five, earning the Race Car Design Challenge badge.

Materials List

Activity 1: As Girls Arrive: Build A Simple Ramp
- Race cars created by girls in Race Car Design Challenge 1. (Note to Volunteers: If you were unable to save the race cars between meetings, Brownies can rebuild their cars during this activity.)
• Folders, poster boards, cardboard, etc., to lean against something to create a ramp
• Books, boxes, tables, etc. to create the height and top of a ramp

Activity 2: Opening Ceremony: Reviewing Force and Friction
• Flag
• Optional: Poster Board with the Girl Scout Promise and Law

Activity 3: Design Your Racetrack
• Poster boards, cardboard, etc., to lean against something to create ramps
• Table(s) or books to create the top of ramps
• Paper or newspaper
• Masking tape

Activity 4: Conduct a Fair Test and Record Results
• Yardstick
• Ramp created by girls in Activity 3: Design Your Racetrack
• Race cars created by girls in Race Car Design Challenge 1 or rebuilt in Activity 1: As Girls Arrive: Build a Simple Ramp
• Optional: Phone or camera to capture “photo finishes”

Activity 5: Share What You Learned
• Race cars redesigned by girls in Activity 4: Conduct a Fair Test and Record Results

Activity 6: Closing Ceremony: Awards
• Race Car Design Challenge badge

(Note to Volunteers: You can buy these awards from your council shop or the Girl Scouts’ website.)

Detailed Activity Plan

Activity 1: As Girls Arrive: Build a Simple Ramp

Time Allotment
10 Minutes

Materials
Race cars created by girls in Race Car Design Challenge 1. (Note to Volunteers: If you were unable to save the race cars between meetings, Brownies can rebuild their cars during this activity.)

- Folders, poster boards, cardboard, etc., to lean against something to create a ramp
- Books, boxes, tables, etc. to create the height and top of a ramp

Steps
Prior to the meeting, create a sample ramp for Brownies. You may make a simple ramp by placing strips of cardboard or folders on textbooks.

As Brownies arrive, welcome them, and have them work in pairs or small teams to build a simple ramp to start testing their race cars.

Optional: If you were unable to save the race cars between meetings, Brownies can rebuild them.

SAY:
Today, you’re going to redesign and race your cars.

Looking at my ramp, do you think you could create one for your race car?

Once you create it, see how your race car rolls down.

Have Brownies create simple ramps and begin to test their race cars.

If there’s time, encourage Brownies to redesign their ramps to see how it affects their car’s roll.

SAY:
What happens if you change the height your ramp? Does it affect how fast your car rolls down the ramp?

Lead them to discover that the height/incline of the ramp affects the speed of the car as it goes down, i.e. it goes slower when there is less slope, and faster when there is more incline.

Activity 2: Opening Ceremony: Reviewing Force and Friction
Time Allotment
10 Minutes

Materials
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

Steps
Recite the Pledge of Allegiance and the Promise and Law.

Conduct any troop business.

Review force and friction with Brownies, and explain today’s engineering challenge to Brownies.

SAY:
Does anyone remember what force is? What’s friction? (Answer: Force is the strength or energy that creates movement. Friction is a force that slows moving objects.)

What did you learn about force and friction from testing your cars last time?

Girls may say: Friction affects how fast it goes, the size of the car affects its speed, wheels reduce friction, etc.

Last time, you built your race car. You learned about force, friction, and how the size and weight of a car can affect its speed.

Then, you just built mini ramps to test how your car rolls down an incline.

Did you discover anything about your car’s speed?

Girls may say: It went faster down the ramp then along the ground, the speed changed with the ramp’s height, etc.

How does the car roll down the ramp?

Girls may say: It rolls, etc.
There’s something all around us that keeps us on the ground. It also helps your race car to roll down the ramp without you pushing it. Does anyone know what that is? (Answer: Gravity.)

Gravity is a strong force that pulls objects, including us and rolling cars, to the ground.

For example, what happens when you jump up? Want to test and find out? Jump on the count of three!

One, two, three, jump!

Brownies jump.

Explain how gravity affects the race car.

SAY:
When you jump up, gravity brings you back down to the ground.

How do you think gravity affects your race car? (Answer: It move the car down the ramp!)

Just like gravity brings you back to the ground, gravity moves the race car down the ramp without you having to push it.

Today, you’ll have the chance to use all you’ve learned to design a giant racetrack before we have a Troop Car Chase to see whose car goes the furthest!

Activity 3: Design Your Racetrack

Time Allotment
10 Minutes

Materials
- Poster boards, cardboard, etc., to lean against something to create ramps
- Table(s) or books to create the top of ramps
- Paper or newspaper
- Masking Tape

Steps
Divide girls into small groups to build their racetrack for Step Four of the Race Car Design Challenge.

Explain fair tests to the Brownies.

**SAY:**

*Now it’s time for you to design a race track and test your car on the track.*

*When we do this experiment, we need to make sure it’s a “fair test.”*

*A fair test means that we’re only changing one thing at a time. Everything else needs to stay the same.*

*So, say we want to measure which race car gets down the ramp fastest. If we release one car slowly but give the second one a push, that’s not a fair test.*

*If you want to do a fair test, you can’t give another car an advantage. Only one thing gets changed in a fair test, and in this example the only change would be the car itself.*

Brownies design their racetracks in small groups.

**SAY:**

*Now, work in groups to create larger ramps that more than one car can go down at a time.*

*You might lean a big piece of heavy cardboard against a table or something else might work event better. Put tape at the end of the table as a finish line.*

Float around the room as girls design their race tracks using the materials and masking tape.

If girls have trouble keep their cars on the tracks, encourage them to create “side rails” on their ramps by attaching rolled up paper or newspaper to the sides of their ramp with masking tape.

If girls ask you for help with their designs, try not to tell them what to do. Instead, ask questions, such as, “What have you tried so far? What do you think would happen if you tested your car on that track? How could you change the track? How do you think that will change the way your car races?”
Remind them that they will get to test their ideas when they do the next activity.

**Activity 4: Conduct a Fair Test and Record Results**

**Time Allotment**
20 Minutes

**Materials**
- Yardstick
- Ramp created by girls in Activity 3: Design Your Racetrack
- Race cars created by girls in Race Car Design Challenge 1 or rebuilt in Activity 1: As Girls Arrive: Build a Simple Ramp
- Optional: Phone or camera to capture “photo finishes”

**Steps**
Divide Brownies into pairs or small groups to test their cars for Step Four of the Race Car Design Challenge.

Give the girls time to test their cars on their race tracks, keeping the following definitions in mind:

- **Fair test**: Change only factor at a time while keeping all other conditions the same.
- **Failure point**: The specific part of a design or build that isn’t working.

Circulate among the groups of girls to guide the testing process.

When a new design improves the car, ask them to talk about why they think the improvements helped. If a new design “fails,” ask the girls to talk about what went wrong. Remind them that failure in design is an opportunity to collect valuable data that can help spark ideas for new solutions.

Have the girls race their finished cars.

Use a yardstick as the starting line. Raise the yardstick straight up to make sure all the cars go at the same time.

**Optional**: Set up a camera or phone to capture “photo finishes.”
Activity 5: Share What You Learned

Time Allotment
10 Minutes

Materials
- Race cars redesigned by girls in Activity 4: Conduct a Fair Test and Record Results

Steps
Have Brownies form a Friendship Circle and share their results for Step Five of the Race Car Design Challenge.

Let girls present in their own way, offering prompts as needed to help them consider what they’ve learned.

Sample prompts include:
- *What made the fastest car so fast?*
- *What could make the slowest car go faster?*
- *When did you fail? How did you improve your design?*
- *Were the races fair tests? How could you improve the track?*
- *If you had more time, what would you try next?*

Make sure every girl gets a chance to speak.

Activity 6: Closing Ceremony: Awards

Time Allotment
10 Minutes

Materials
- Race Car Design Challenge award

(Note to Volunteers: You can buy these awards from your council shop or the Girl Scouts’ website.)

Steps
Brownies receive their Race Car Design Challenge badge.

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SAY:
You’ve now earned the Race Car Design Challenge badge.

Please step forward when I say your name to accept your award.

Lead a round of applause for each Brownie as she steps forward.

SAY:
You have earned your Race Car Design Challenge award, which means you have designed cars and race tracks, then carried out “fair tests” to learn how design affects speed.

When you leave here, who do you want to tell about what you learned?

Girls may say: My parents, my brothers and sisters, my friends at school.

That’s great! When you learn something, it’s fun to pass it on to others. We can all learn from each other.

End the meeting with a Friendship Squeeze.

Now that I’ve earned this badge, I can give service by:

- Showing Daisies that engineering can be fun by demonstrating my Leap Bot.
- Sharing what I learned about gravity, force, and energy with my friends or family.
- Letting others know what engineers do by doing a Show-and-Tell with my Leap Bot at school.
Design Challenge Badges
Glossary for Brownes

Brownies may not know some of the words used in these badges. Here are definitions you can share with them:

**Engineers** are people who like to know how things work. They design and build things people use every day, like computers, phones, roads, bridges and cars.

**Force** is the strength or energy that creates movement. Push and pull are examples of force.

**Gravity** is a force that pulls objects toward each other and towards the earth.

**Potential energy** is the energy stored in your body and everything else in our world.

When potential energy is released, it becomes **kinetic energy** which brings bodies and object to move.

**Thrust** is a force that slows moving objects.

**Drag** is the force (air molecules) that acts against something in flight.

**Lift** is a force that pushes back up on the wings during flight.

**Balanced forces** exist when forces are equal on an object. When the forces are balanced, the object does not move.

**Unbalanced forces** exist when forces are unequal on an object. When the forces are unbalanced, it moves in the direction of the greater force.

**Features** are parts of a product that are designed make them more useful.

**Friction** is a force that slows moving objects.
Brownie Design Challenge Badges: Materials List

Leap Bot Design Challenge 1

Activity 2: Opening Ceremony: All About Solving Problems
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

Activity 3: Learn About Springs
- Sample Leap Bot made from the GoldieBlox Making Things Zoom kit

Activity 4: Build Your Leap Bot
- GoldieBlox Making Things Zoom kit (one set for each pair or small team)

For each Leap Bot, girls will need these GoldieBlox:
- 4 mini axles
- 1 long axle
- 2 angle joints
- 2 elbow joints
- 4 spacers
- 4 pegs
- 1 star coupler
- 3 wheel hubs
- 3 small wheel ends
- 2 big wheel ends
- 1 long spring

Leap Bot Design Challenge 2

Activity 1: As Girls Arrive: Prepare For Testing
- Leap Bots created by girls in Leap Bots Design Challenge 1. (Note to Volunteers: If you were unable to save the Bots between meetings, Brownies can rebuild them during this activity.)
- Leftover pieces from the GoldieBlox Making Things Zoom kit (one set for each pair or small team).

Activity 2: Opening Ceremony: Leap Bot Forces
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

Activity 3: Create a Way to Test How Well Your Leap Bot Performs
- Leap Bots created by girls in Leap Bot Design Challenge 1 or Activity 1: As Girls Arrive: Prepare for Testing
- Rulers, yardsticks, etc.
- Tape
- Paper

Activity 4: Record the Results of Your Test
- Leap Bots created by girls in Leap Bot Design Challenge 1 or Activity 1: As Girls Arrive: Prepare for Testing
- Leap Bot Testing Stations created by girls in Activity 3: Create a Way to Test How Well Your Leap Bot Performs
- Leap Bot Recording Sheet
- Long and Short springs from the GoldieBlox Making Things Zoom kit (3 or more from each set for each pair or small team)
- Leftover pieces from the GoldieBlox Making Things Zoom kit (for each pair or small team)
Brownie Design Challenge Badges: Materials List

Leap Bot Design Challenge 2 (continued)

**Activity 5: Share Your Results**
- Leap Bot Recording Sheets, filled out by girls in Activity 4: Record the Results of Your Test

**Activity 6: Closing Ceremony: Awards**
- Leap Bot Design Challenge award

(Note to Volunteers: You can buy these awards from your council shop or on the Girl Scouts’ website.)

Fling Flyer Design Challenge 1

**Activity 1: As Girls Arrive: Engineering Paper Airplanes**
- Paper (Construction, white, etc. A variety of papers gives girls the opportunity to try making planes with different paper weights.)
- Crayons, colored markers

**Activity 2: Opening Ceremony: Taking Flight!**
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

**Activity 3: Learn About the Forces that Affect Flight**
- Paper Airplanes from Activity 1: As Girls Arrive: Engineering Paper Airplanes

**Activity 4: Design and Build a Fling Flyer**
- GoldieBlox Making Things Zoom kit (one set for each girl, pair, or small team)
- Sample Fling Flyer
- Paper
- Pencils
- Optional: Fling Flyer Investigation worksheets

For each Fling Flyer, girls will need these GoldieBlox:
- 2 mini axles
- 1 long axle
- 2 star stoppers
- 1 angle joint
- 2 T-joints
- 1 craftstruction wing (Alternatively, you can prepare or have girls create their own wings using cardstock, construction, or copy paper and scissors/paper hole push.)
- 1 rubber band
Brownie Design Challenge Badges: Materials List

Fling Flyer Design Challenge 2

**Activity 1: As Girls Arrive: Prepare for Testing**
- Fling Flyers created by girls in Fling Flyer Design Challenge 1. *(Note to Volunteers: If you were unable to save the Flyers between meetings, Brownies can rebuild them during this activity.)*

**Activity 2: Opening Ceremony: Forces that Affect Flight**
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

**Activity 3: Test Your Fling Flyer**
- Fling Flyers created by girls in Fling Flyer Design Challenge 1 or Activity 1: As Girls Arrive: Prepare for Testing
- Cardstock, construction paper, or copy paper (the heavier the better)
- Scissors or hole punches
- Leftover pieces from the GoldieBlox Making Things Zoom kit (one set for each pair or small team)
- Masking tape
- Cone, rock, or anything else to mark the furthest distance flown

**Activity 5: Brainstorm Ways to Improve Your Design**
- Fling Flyers from Activity 3: Test Your Fling Flyer
- Cardstock, construction paper, or copy paper (the heavier the better)
- Scissors or hole punches
- Leftover pieces from the GoldieBlox Making Things Zoom kit (one set for each pair or small team)

**Activity 6: Closing Ceremony: Awards**
- Fling Flyer Design Challenge award
  *(Note to Volunteers: You can buy these awards from your council shop or on the Girl Scouts’ website.)*

Race Car Design Challenge 1

**Activity 1: As Girls Arrive: Playing with Force and Friction**
- Sports and game balls (one for each pair of girls). Bring different types of balls for girls to roll and observe friction. For example, you might bring a marble, tennis ball, basketball, ping pong ball, baseball, etc.
- Create two lines with masking tape on the floor. Each Brownie should sit on the line, facing their partner.

**Activity 2: Opening Ceremony: Engineering Speed**
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

**Activity 3: Learn How Design Can Affect Speed**
- Toy car to demonstrate force and friction
Brownie Design Challenge Badges: Materials List

Race Car Design Challenge 1 (continued)

Activity 4: Design and Build Your Race Car
- GoldieBlox Making Things Zoom kit (one set for each pair or small team.) Feel free to add additional pieces from personal GoldieBlox kits that you or your Girl Scouts may own.

Activity 5: Closing Ceremony: Share Your Design
- Race Cars built by Brownies in Activity 4: Design and Build Your Race Car

Race Car Design Challenge 2

Activity 1: As Girls Arrive: Build A Simple Ramp
- Race cars created by girls in Race Car Design Challenge 1. (Note to Volunteers: If you were unable to save the race cars between meetings, Brownies can rebuild their cars during this activity.)
- Folders, poster boards, cardboard, etc., to lean against something to create a ramp
- Books, boxes, tables, etc. to create the height and top of a ramp

Activity 2: Opening Ceremony: Reviewing Force and Friction
- Flag
- Optional: Poster Board with the Girl Scout Promise and Law

Activity 3: Design Your Racetrack
- Poster boards, cardboard, etc., to lean against something to create ramps
- Table(s) or books to create the top of ramps
- Paper or newspaper
- Masking tape

Activity 4: Conduct a Fair Test and Record Results
- Yardstick
- Ramp created by girls in Activity 3: Design Your Racetrack
- Race cars created by girls in Race Car Design Challenge 1 or rebuilt in Activity 1: As Girls Arrive: Build a Simple Ramp
- Optional: Phone or camera to capture “photo finishes”

Activity 5: Share What You Learned
- Race cars redesigned by girls in Activity 4: Conduct a Fair Test and Record Results

Activity 6: Closing Ceremony: Awards
- Race Car Design Challenge award

(Note to Volunteers: You can buy these awards from your council shop or on the Girl Scouts’ website.)
Brainstorming Tips: Think, Pair, Share

How to Run a Think, Pair, Share Activity:

Tell girls that they’re going to brainstorm answers to your question using “Think, Pair, Share.”

Lead girls through the basic steps by telling them they will:

1. **Break into small groups.**
2. **Listen to the question or prompt.**
3. **Think about their answers.**
   - Girls may want to write their answers down.
   - Twenty seconds should be enough time, since girls will need to sit quietly.
4. **Pair with other girls.**
   - Girls talk with one to three other girls (depending on group size), making sure everyone has a chance to share their answers. If there’s time, it’s OK for girls to ask questions about each other’s answers.
   - For pairs, 20 seconds should be enough time. If your troop enjoys discussion, consider extending this to 1 to 2 minutes.
5. **Share with the group.**
   - Girls share their answers with the larger group.
   - This can be completed in 20 – 30 seconds, but will run longer based on group size and how the group sharing is done.

There are two ways to set up group sharing:

- **Strongly Recommended:** One girl shares the best/most interesting/summary answer for the group. This approach is great if you’re running short on time. It also helps develop conflict resolution and compromise skills.
- **Optional:** Each girl shares her partner’s answer. This helps girls develop active listening skills, but will run longer because all girls are sharing.
The Girl Scout Promise
On my honor, I will try:
   To serve God and my country,
   To help people at all times,
   And to live by the Girl Scout Law.

The Girl Scout Law
I will do my best to be
   honest and fair,
   friendly and helpful,
   considerate and caring,
   courageous and strong, and
   responsible for what I say and do,
and to
   respect myself and others,
   respect authority,
   use resources wisely,
   make the world a better place, and
   be a sister to every Girl Scout.
Race Car Design Challenge badge

Spring Car

engineering concept:
SIMPLE MACHINES

I built it!

build date:

Bloxsome!

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