

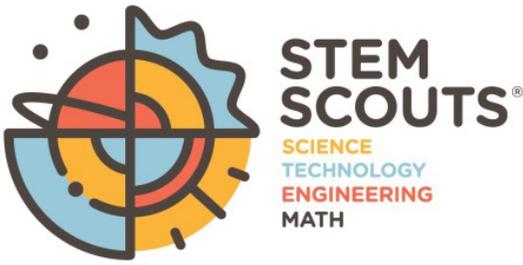
STEM SCOUTS®

SCIENCE
TECHNOLOGY
ENGINEERING
MATH

Technology Lab: Lab Notebook – Off to the Races



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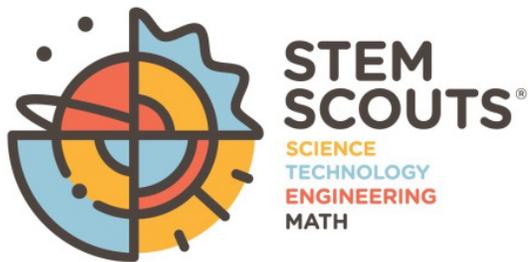


Lab Notebook



Off to the Races

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Lab Notebook



Off to the Races

Overview

In this module, you will learn how to optimize the speed of a racing car. You will discover what friction is and how it affects the performance of a car, and you will learn about propulsion, acceleration and deceleration, and rocket-powered vehicles. You and your team will design several race courses, build model cars to run on those race courses, and race each other.

This module takes six STEM Scout meetings of approximately 90 minutes each.

Meeting 1: How to Go Fast

You will learn the key principles of performance for your model cars and look at the different options available to tune the performance of your cars. You and your team will also design different race courses to run the cars on later in the module.

Meeting 2: Design and Build

You and your team will design one or more cars, following the race rules, and then start to build them. You can take the cars home to work on prior to the next meeting.

Meeting 3: Build Tracks; Test and Refine Cars

You and your team will build the different race tracks and test your cars on them. You can continue working on your cars or make some design modifications in this meeting and at home before the next meeting.

Meeting 4: Race Day!

You and your team will compete against other teams in racing your cars on the different tracks.

Meeting 5: Design a “No-Rules” Race Car

You and your team will design modifications to your car to make it super-fast. For this activity, there are no rules! Anything goes! You will start on those modifications in the lab and can continue them at home before the final meeting.

Meeting 6: No-Rules Race Day

You and your team will compete against other teams in racing your modified cars on the different tracks.



Meeting 1: How to Go Fast



Meeting 1: How to Go Fast

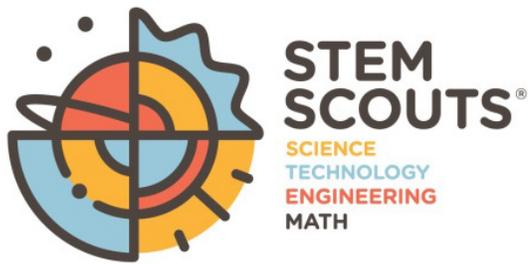
Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today's theme is *helpful*, as in *I will be helpful to my teammates in working together to design race courses.*



Lab Notebook



Meeting 1: How to Go Fast

Activity Overview

There are three activities in this lab. In the first activity, you and your team will learn all about the model car kits and what affects the performance of model cars.

In the second activity, you will learn how to use woodworking tools.

In the third activity, you and your team will design different race courses, taking into account what is available around your lab meeting room.

Background

Racing unpowered cars by youth goes all the way back to the first days of automobile racing. In 1914, the Vanderbilt Cup was an established important race event for early cars. That year, the city of Santa Monica, California, decided to hold a junior version for younger people that included some cars with no engines and a ramp to get the cars moving.

According to the Soap Box Derby® website, a newspaper photographer in Dayton, Ohio, came across a group of boys racing homemade cars in 1933. The event so impressed him that he decided to establish a national program.

This was the start of the All-American Soap Box Derby, an annual race for unpowered cars driven by young people, initially only boys ages 11 to 15. Today, race participants must be between 7 and 21 years old, depending on the race division, and the races are open to both girls and boys.

In 1953, the first Cub Scout pinewood derby was held. Most Cub Scouts at that time were too young to participate in soap box derbies, so a Cubmaster came up with the idea of building a miniature wooden car that raced down a ramp. The idea became very popular and was adopted by the Boy Scouts of America as an official program for Cub Scouts. The pinewood derby is still very popular today, and many BSA councils across the country hold adult or corporate races for the many adults who fondly remember building cars as Cub Scouts.

In 2011, the BSA developed a larger version of the Pinewood Derby® Car Kit for older boys that added a CO₂ gas cartridge to power the cars to high speeds and add a whole new dimension to the kinds of races that were possible. That car is the Blastcar, which is the basis for this module.

Although the Blastcars are “jet propelled” by the CO₂ gas cartridges, all of the speed and performance principles that make winning Soap Box Derby cars and pinewood derby cars still apply.

Safety Moment

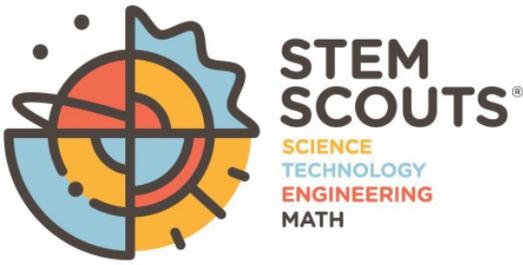
NEVER insert the CO₂ fuel cartridges in the wood block until instructed to do so.

The saw has sharp teeth. Never grab the blade or put the blade on any part of your or anyone else’s body.

The drill bits are also sharp; handle them with care.

You will be using sharp woodworking tools today. Always look at the area you will be working in and set it up so that you are not going to accidentally cut the table, other furniture, yourself, or anyone else.

Sawdust and wood shavings will probably get on the floor and can make the floor very slippery. Clean up regularly and take care when walking around.



Lab Notebook



Meeting 1: How to Go Fast

When you are sanding, be careful to not get sawdust in your eyes. If you do, get help from a Lab Manager to wash your eyes out.

Experiment

Get into teams of four. You will stay in these teams for all six Lab meetings in this module.

Activity 1: Examine Kits and Guidelines (10–15 minutes)

Materials List

- 4 Blastcar Car Kits
- Blastcar CO₂ fuel canisters

Open one of the car kits. Your team will be building several of these cars during this module. Each car kit has the following items:

- 1 block of wood, predrilled for the fuel cartridge
- 4 wheels
- 1 axle kit (4 screw axles, 1 Allen wrench, 2 eyelets)
- 1 copy of Blastcar Guidelines and Instructions

Your Lab Manager will have one of the launch kits opened up where your team can go inspect it. The launch kit includes:

- 1 2-car launcher
- 1 race line reel
- 2 start/finish plates
- 4 start/finish screws
- Launch Instruction Guide

Look at the Blastcar Guidelines and Instructions (open all four kits so each team member has one). Read each section individually and then discuss it with your team. Make sure you all understand the principles and guidelines.

- Review the Suggested Race Courses section and discuss the differences between them and what that means for a car design. Look at the space available to you to design and build a course.
- Review the Design Car Kit section and discuss it with your team.
- Review the Event section, paying close attention to the rules. Discuss the rules and how the race is to be run with your team.
- As a team, decide how you will work together to design and build a course, and to design and build your cars.



Meeting 1: How to Go Fast

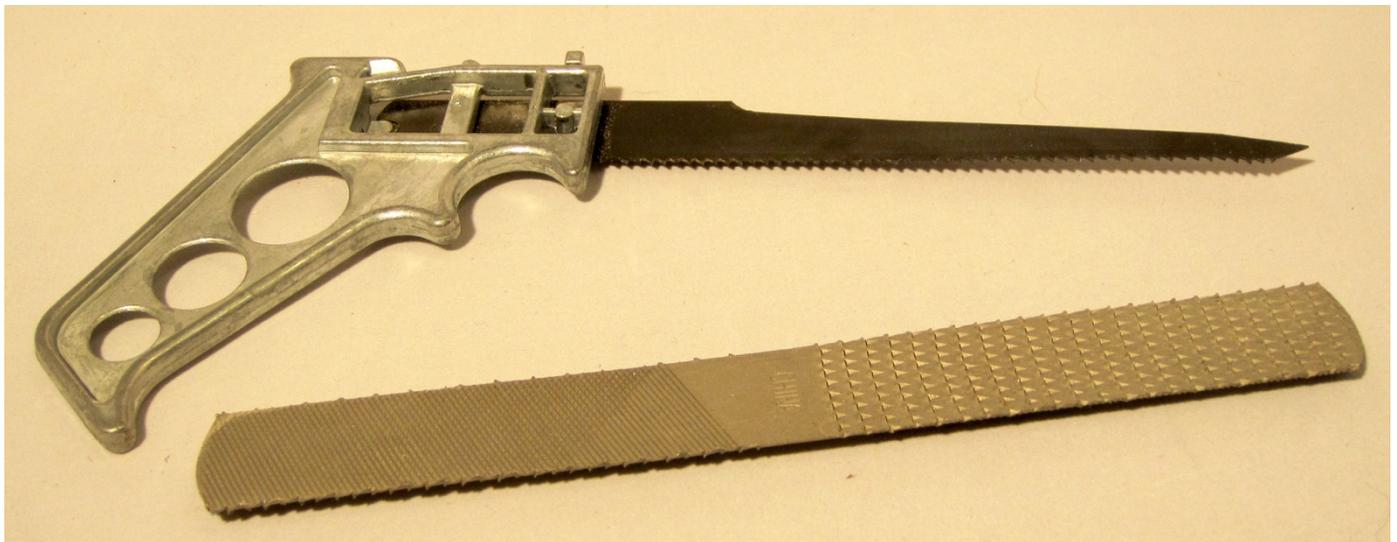
Activity 2: Woodworking Tool Tutorial (30 minutes)

Materials List

- 4 Blastcar Car Kits
- Blastcar CO₂ fuel cartridges
- 1 pin vise
- 1 3/32-inch drill bit
- 1 keyhole saw
- 1 rasp
- 1 sheet each of fine and coarse sandpaper
- 1 8-inch long, 5/8-inch diameter wooden dowel
- Scraps of wood to practice on

The tools you have in the kit are a keyhole saw, a coarse/medium wood rasp, a pin vise with a 3/32-inch drill bit, and coarse and fine sandpaper, as well as a piece of wooden dowel. These are shown and explained below. Your Lab Manager may give you some scraps of wood that you can use to practice using the tools on. Don't practice on the Blastcar kits!

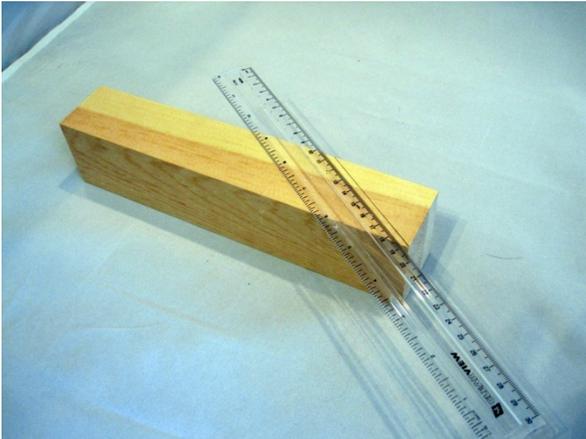
The keyhole saw is a rough cut saw for roughly shaping the wooden block. Never force or put pressure on a saw to try to make it cut faster. You will end up bending or breaking the blade, or it will get stuck. Put the saw on the cut line and slide it back and forth without pushing down on it. The saw's teeth will cut into the wood all on their own. Patience is key in using a saw properly. Long strokes give you cleaner and faster cuts than short strokes. Your arm should line up with the saw line so it is straight with the saw and there is no angle between your arm and the saw.





Meeting 1: How to Go Fast

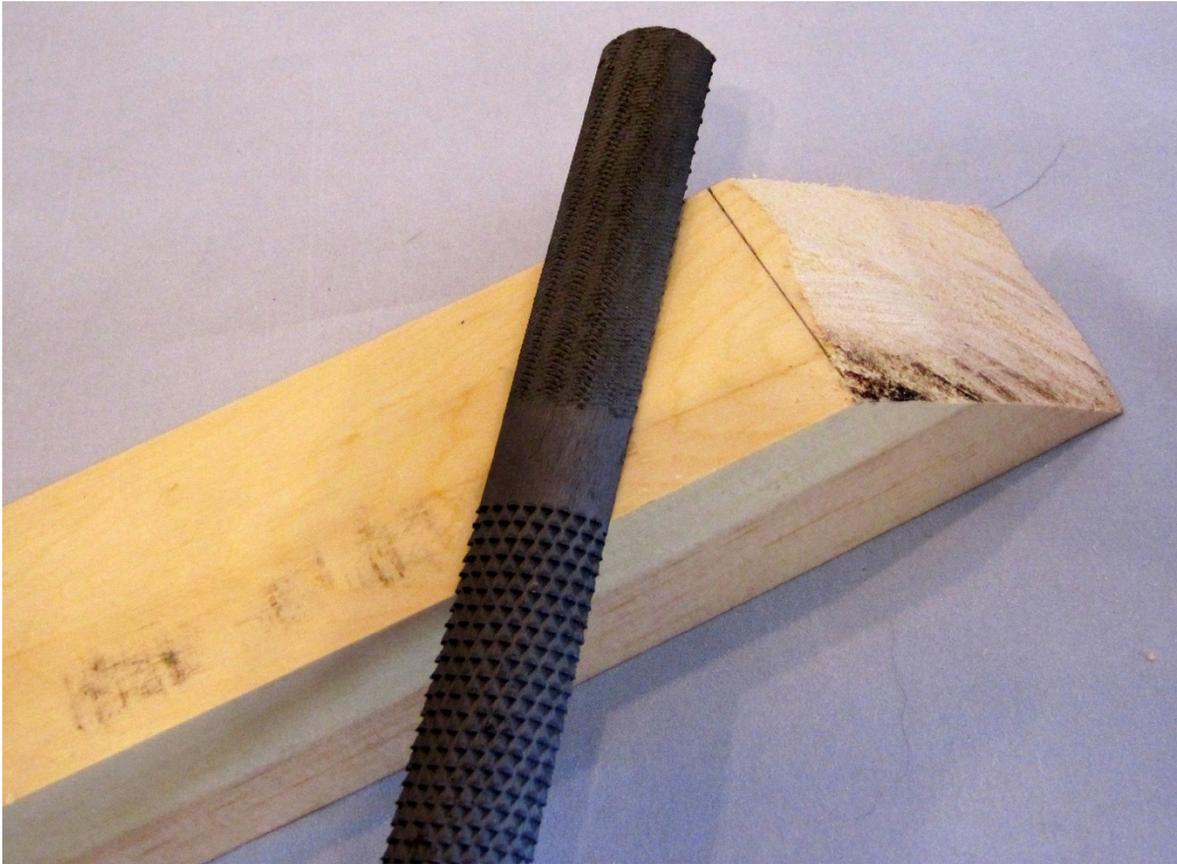
Draw your cut lines on the block of wood and, carefully holding down the block of wood with one hand (or getting a teammate to help you hold it), use the saw to make the rough cut.





Meeting 1: How to Go Fast

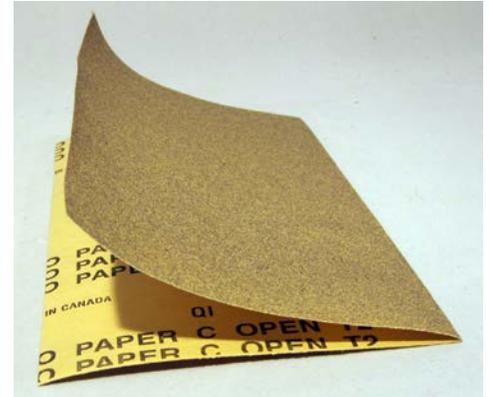
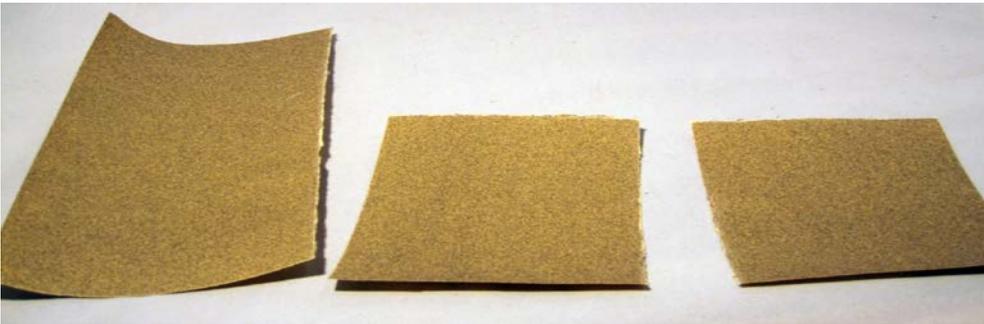
The wood rasp has a coarse set of teeth and a medium set of teeth. Use the coarse teeth to get your shape pretty close to the final shape wanted, then the medium teeth to finish the shape.





Meeting 1: How to Go Fast

Use the coarse and fine sandpaper to smooth out the rasp tooth marks and to smooth the edges and bevel them so you don't get splinters. First, take a sheet of sandpaper and divide it into four pieces. Fold the sandpaper in half to make a crease, then fold it the opposite (so that the backing is out) to crease it all the way through. Now, you can gently separate the two halves. Do the same for each half so you have four pieces from the sheet. These smaller pieces are easier to use.





Meeting 1: How to Go Fast

Here are a couple of simple “space shuttle”-like shapes you can easily make.



Next, measure and mark where the wheels will go. Drawing a straight line at a right angle from the wood block helps you to get the two wheels on each side lined up. It is important that all wheels be the same height from the block, so the axle holes need to be the same distance from the bottom edge.





Meeting 1: How to Go Fast

Use the pin vise and the drill bit to hand drill a pilot hole for the axles.



Next, check the fit of the CO₂ cartridge to the predrilled hole. It should fit snugly all the way into the hole, with only the neck sticking out, yet still be loose enough that you can pull it out again.

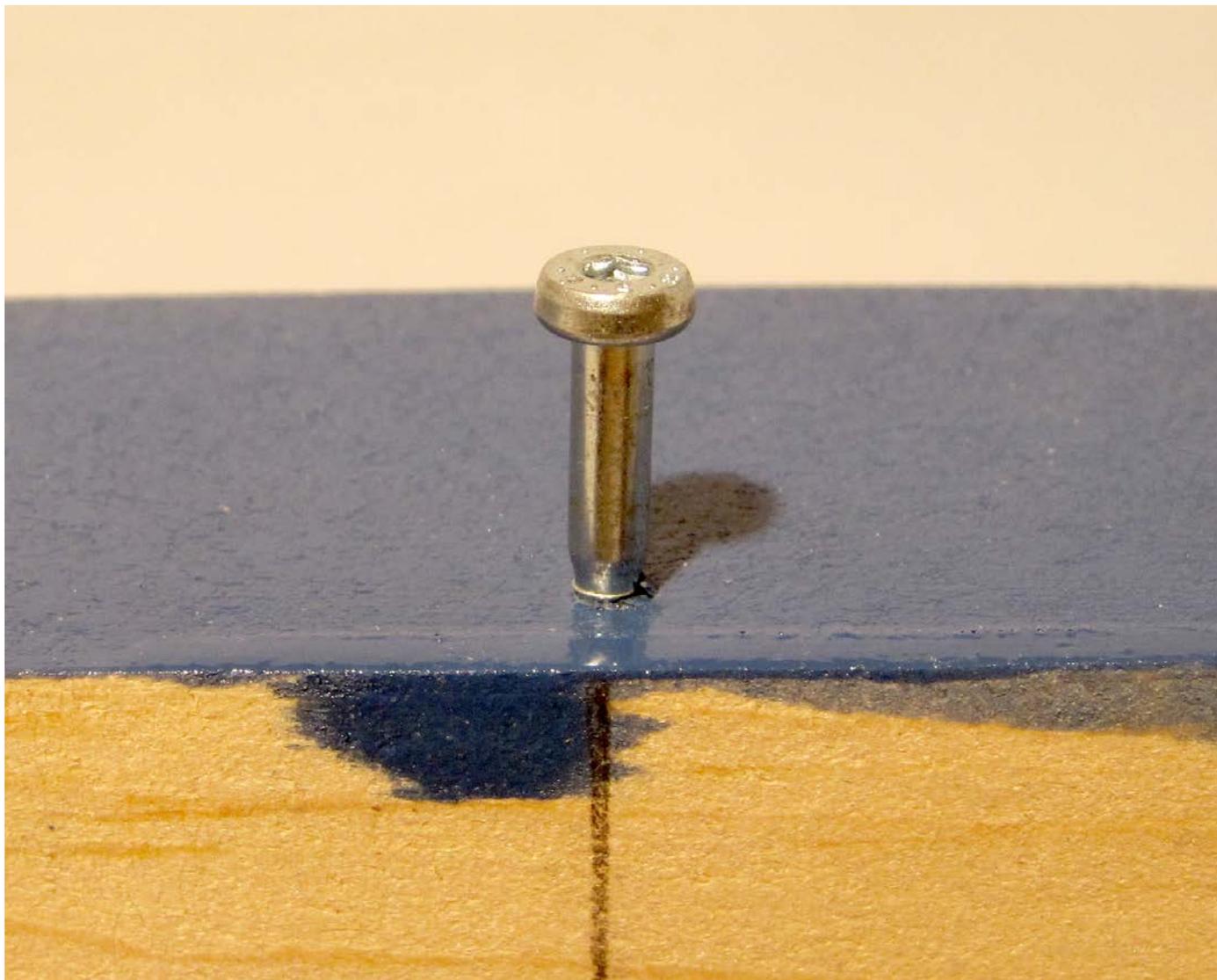
If you cannot get the cartridge all the way into the hole, cut a section of the coarse sandpaper (grit #60), wrap it around the wooden dowel, and use that to sand open the hole a little bit. Do a little sanding at a time and check the fit.





Meeting 1: How to Go Fast

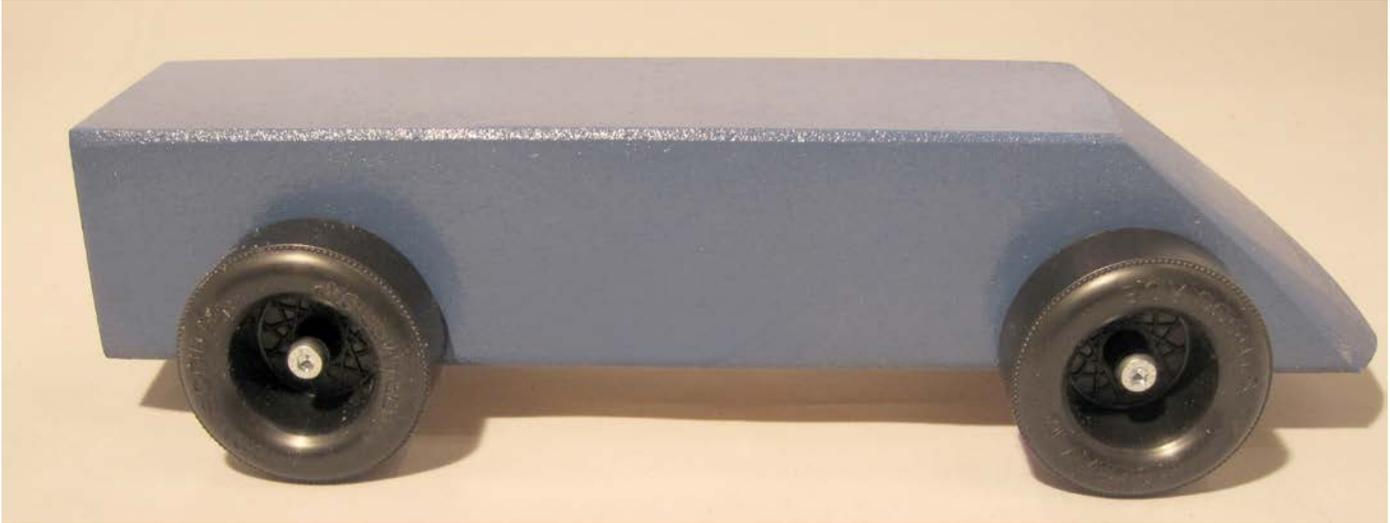
If you are going to paint or decorate the car, do that as the next step and let the paint dry completely before you mount the wheels. To mount the wheels, take the axle screws provided with the Allen wrench and screw one into each hole you drilled until you can't see the threads anymore, then unscrew it. This makes mounting the wheels easier.



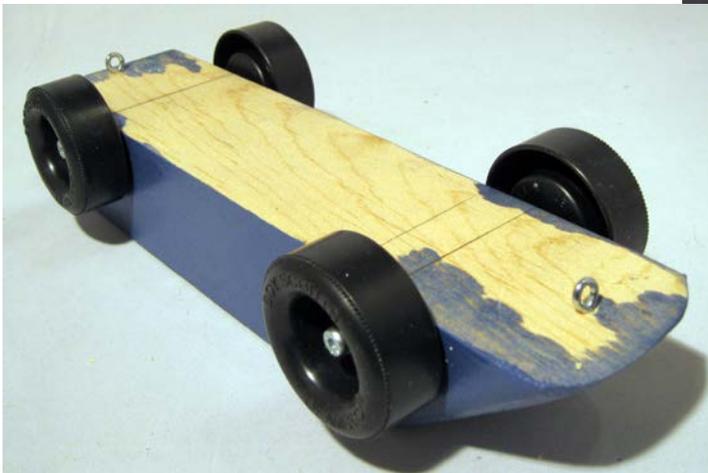
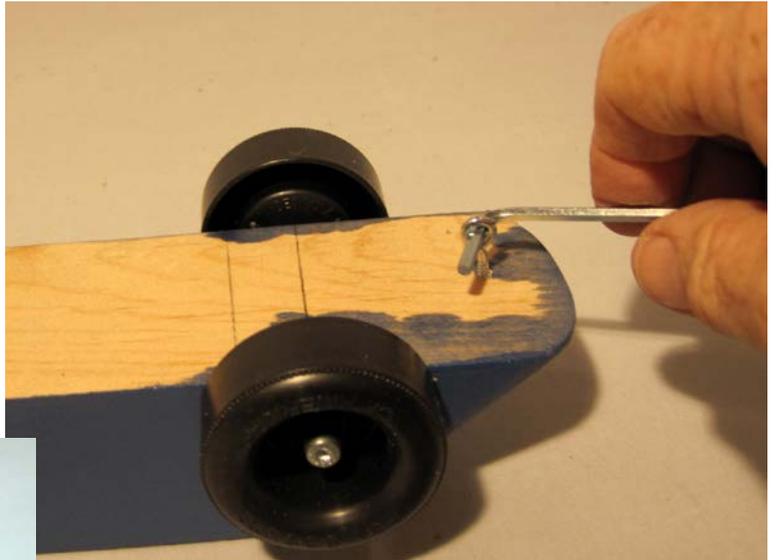


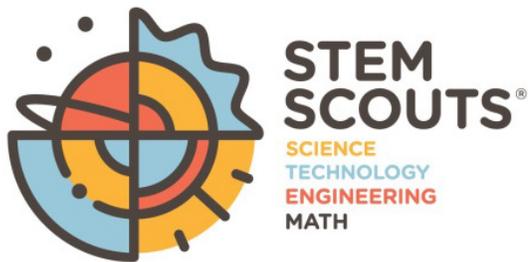
Meeting 1: How to Go Fast

Now, you can mount the wheels with the axles.



To mount the eyelets, use the pin vise and drill bit to make two shallow holes on the underside of the car—one up front and one at the back. Don't drill a deep hole; you just need a starter hole. Then take the eyelets and start screwing them into that shallow hole by hand. As they screw into the wood, it may get hard to turn them by hand. In that case, put the Allen wrench through the eye to get some leverage turning the eyelet. You want the eyelets to be centered on the car body so that the fishing line can slide through as the car races down the track.





Lab Notebook



Meeting 1: How to Go Fast

Activity 3: Design a Race Course (20 minutes)

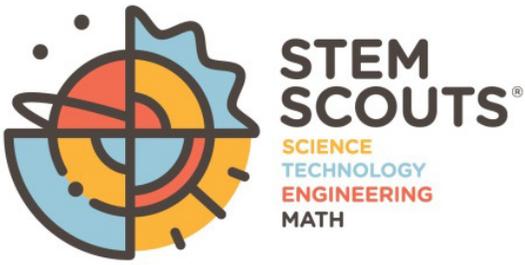
For this activity, form groups of eight Scouts (two teams) to jointly design a course.

Materials List

- Trundle wheel
- Ruler

Two teams will work together to design a race course, taking into account the space available, the incline, surfaces, etc. You can use one of the basic courses described in the guidelines, make a variation of those, or design something unique. You will build your race course in Meeting 3 and race your first car on it to test your designs. Then, during Meeting 4, you and the other teams will race your cars on all the race courses designed by each pair of teams.

Sketch out the race course in your lab notebook. You can use the trundle wheel to measure the distance available.



Lab Notebook



Meeting 1: How to Go Fast

STEM Innovator Moment Notes



Meeting 2: Design and Build



Meeting 2: Design and Build

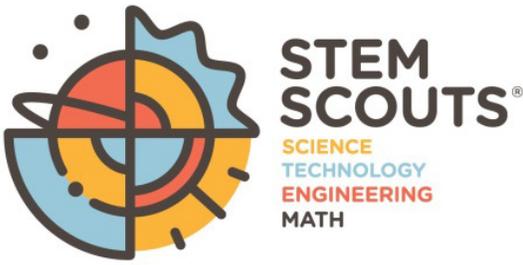
Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today's theme is *obedient*, as in *I will be obedient and follow all the rules for the race in designing our cars.*



Lab Notebook



Meeting 2: Design and Build

Activity Overview

There are two activities in this lab. In the first activity, you and your team will design one or more race cars based on all you have learned from Meeting 1.

In the second activity, you and your team will start to build the cars that you designed. You can continue working on these at home between this meeting and the next one.

Background

The background information for this meeting is included in the Experiment section.

Safety Moment

You will be using sharp woodworking tools today. Always look at the area you will be working in and set it up so that you are not going to accidentally cut the table, other furniture, yourself, or anyone else.

Sawdust and wood shavings will probably get on the floor and can make the floor very slippery. Clean up regularly and take care when walking around.

When you are sanding, be careful to not get sawdust in your eyes. If you do, get help from a Lab Manager to wash your eyes out.

Experiment

Get into the same teams of four that you were in for the previous meeting.

You will use the STEM Scouting Engineering Design Process throughout this module.

Activity 1: Design Race Cars (30 minutes)

Materials List

- Course design your team made in the previous meeting
- 1 copy of Blastcar Guidelines and Instructions from the car kits
- Team laptop with internet access

Step 1: Define the Problem:

You and your team want to design the fastest race car.

Step 2: Conduct Background Research

Review the information you learned in Meeting 1 on the different courses and race car tips and woodworking basics. Here are some useful websites that have information and performance tips you can use.

<https://auto.howstuffworks.com/auto-racing/motorsports/co2-powered-dragster2.htm>

www.science-of-speed.com/How-To/Tune?art=8021

www.co2dragsters.co.nz/assets/Uploads/CO2-Dragster-Design-and-Construction-Notes-for-Students.pdf



Meeting 2: Design and Build

Step 3: Specify Requirements

Review the rules in the Blastcar Guidelines and Instructions for the rules you have to follow in the first race.

You and your team have a critical decision to make at this point. What race course are you trying to win? Are you going to design a race car with optimal performance and speed for the course you and your team designed or one that is good on all race courses? Or are you going to try to make two different cars? Discuss this among yourselves and make a decision. Then add in the requirements pertinent to the kind of car you decided to design.

Make sure you pay attention to the spacing, tolerances, and clearances specified in the guidelines.

You and your team have a total of four car kits to work with for the entire module. You will need to have at least one car for the full rules race and one for the no-rules race. You will need to decide how to allocate the four kits among those activities.

Step 4: Create Alternative Solutions

You and your team should plan a baseline design, and, as you are discussing that design, make note of alternative designs you might want to try if the baseline does not work as well as expected. Capture the design and the alternate ideas in your Lab Notebook.

If you have access to a woodworking expert and tool shop, you can plan a fancier shape of a car. But if you are going to use the basic tools supplied in the kit, we recommend you stick to a simple, basic shape, as shown below.





Meeting 2: Design and Build

Discuss whether you are going to need any special tools to build your cars and where you can get access to them.

Tools Needed	Where to Get Them	Tools Needed	Where to Get Them

Once you have your designs and plans created, move on to the next activity, where you will start building the car.

Activity 2: Start Building Your Prototype (30 minutes)

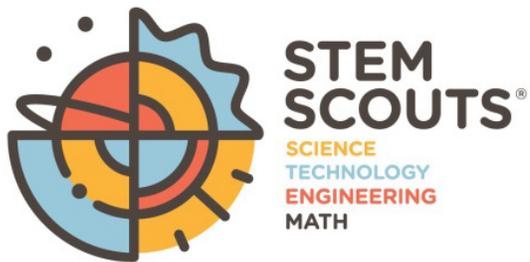
Materials List

- 1–2 Blastcar Car Kits
- 1 pin vise with 2 3/32-inch drill bits
- 2 wood rasps
- 2 keyhole saws
- Coarse and fine sandpaper
- 1 8-inch long, 5/8-inch diameter wooden dowel
- 1 digital scale (shared between up to four teams)
- Paper towels and water
- Broom and dustpan
- Optional: clamps and other woodworking tools as needed

You will continue with the STEM Scouts Engineering Design Process started in the first activity.

Step 5: Build a Prototype

Using the primary design you and your team created in Activity 1, start to build your prototype (or multiple prototypes). You will almost certainly not finish the prototype in this activity. You and your team can take your kits and tools home with you to get together and work on the cars between this meeting and the next or arrange to meet at someone’s home or wood shop where you have access to other tools.



Lab Notebook



Meeting 2: Design and Build

Cleanup

Clean up any wood shavings and sawdust.

If you are going to work on your cars between now and the next meeting, check out any tools and let your Program Manager know what you are taking with you.

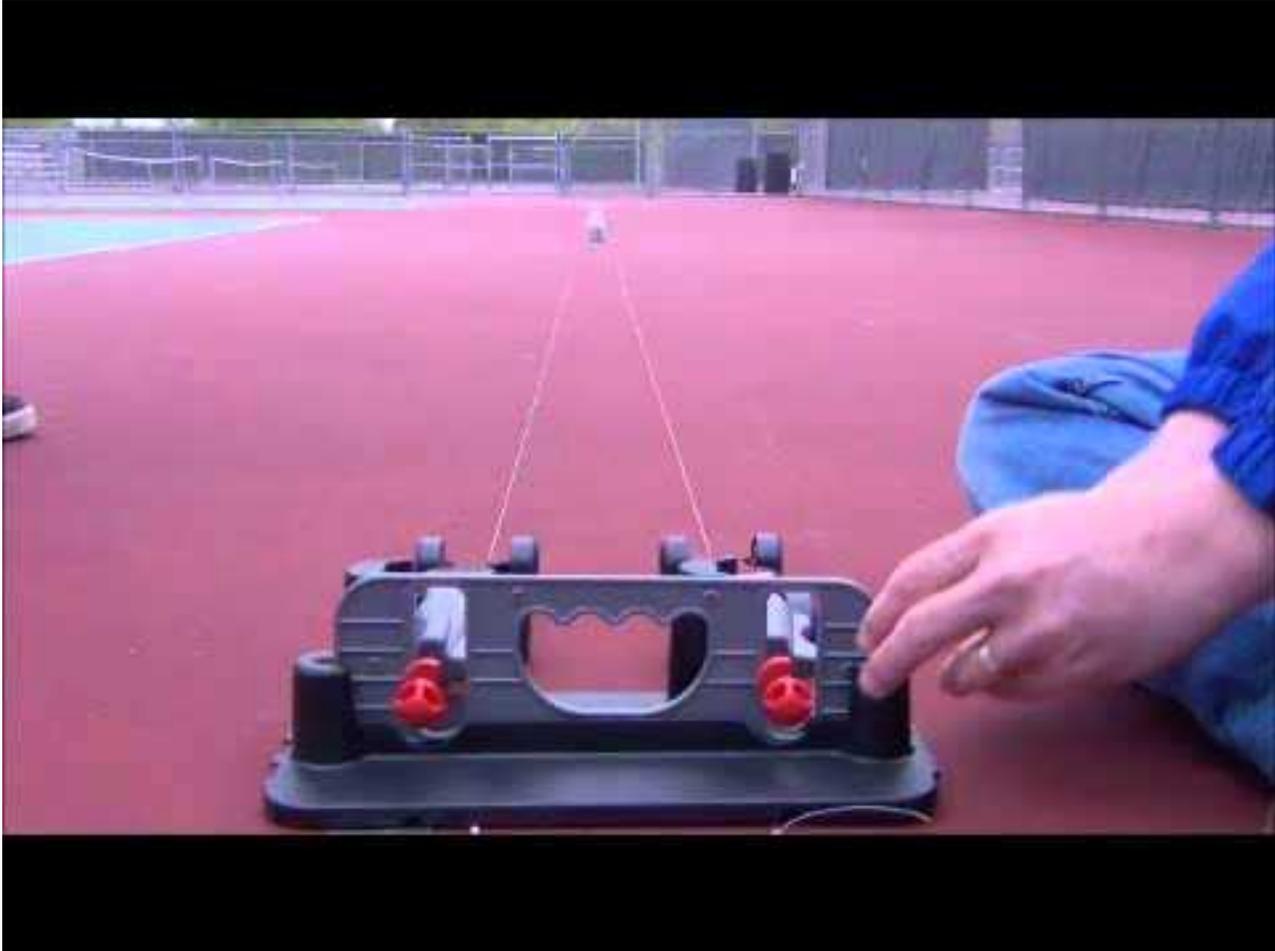
Exit all applications on the laptop, fully power it down, and return it to your Program Manager.

Clean your area, and be sure no trace is left behind.

STEM Innovator Moment Notes



Meeting 3: Build Tracks; Test and Refine Cars



Meeting 3: Build Tracks; Test and Refine Cars

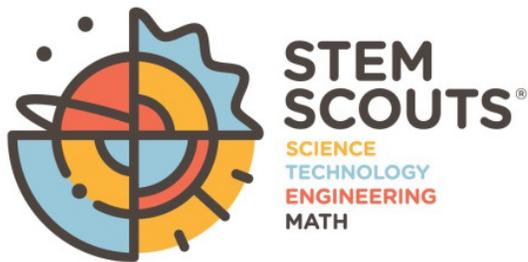
Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today's theme is *courteous*, as in *I will be courteous in sharing use of the launcher with other teams.*



Lab Notebook



Meeting 3: Build Tracks; Test and Refine Cars

Activity Overview

There are three overlapping activities in this lab. In the first activity, you and your team will build the race courses you designed in Meeting 1.

In the second activity, you will test your cars on the race courses.

In parallel with this, you and your team can continue working on your cars, design some modifications based on test results, and take the cars home to work on them between this meeting and the next. The next meeting is the race day, so cars must be finished by then.

Background

There is no additional background information for this meeting.

Safety Moment

You will be using sharp woodworking tools today. Always look at the area you will be working in and set it up so that you are not going to accidentally cut the table, other furniture, yourself, or anyone else.

Sawdust and wood shavings will probably get on the floor and can make the floor very slippery. Clean up regularly and take care walking around.

When you are sanding, be careful to not get sawdust in your eyes. If you do, get help from a Lab Manager to wash your eyes out.

The race courses will have fishing line stretched for the entire length for the cars to connect to. This line can be almost invisible, so be careful that you don't trip over the line when walking near a race course.

NEVER put CO₂ cartridges into the cars until the cars are ready to race and are already tethered to the race line. Once the car is tethered to the race line, insert the CO₂ cartridge and then carefully move the car onto the launcher.

Everyone must stay at least 10 feet away from the launcher and race course.

Only Lab Leaders should operate the launcher.

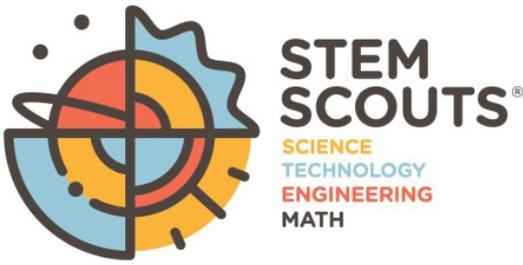
Experiment

Get back into the same two teams of four that you were in for previous meetings.

Activity 1: Build Race Courses (15–20 minutes)

Materials List

- Blastcar Car Launch Kit (one for every two teams)
- Extra launch line (if needed)
- 1 digital scale (shared between up to four teams)
- 1 stopwatch (shared between two teams)
- Duct tape (shared between two teams)
- Trundle wheel (shared between two teams)
- Towel or blanket to provide a soft stop
- Optional: ramp-building materials



Lab Notebook

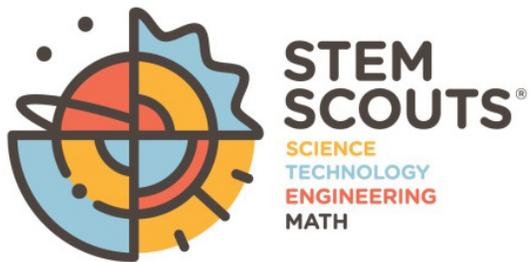


Meeting 3: Build Tracks; Test and Refine Cars

- 1-2 cars previously built by your team
- 3 CO₂ gas cartridges per car
- 1 tube graphite lube
- 1 copy of Blastcar Guidelines and Instructions (in Blastcar kit)
- 1 ruler

Your Lab Leader or the Principal Investigator will go around the lab numbering all cars, so that each has a unique number.

Using the plans developed in Meeting 1, you and the other Scouts in your group of eight should go to the course area designated by your Lab Manager and set up your course. Follow the instructions in the Blastcar Guidelines and Instructions for **Setting Up The Track**. Use the trundle wheel to measure the distance of the course and write that down in the Course Information Table on the next page.



Lab Notebook



Meeting 3: Build Tracks; Test and Refine Cars

Course Information Table

Course No.	Designed By	Type (from guidelines)	Description	Length (feet)



Meeting 3: Build Tracks; Test and Refine Cars

Your team has three CO₂ gas cartridges for each car you built previously. Plan with your group of eight how you want to test your cars and use these cartridges. They have to last through this entire meeting.

Inspect each car and record the weight and measurements in Car Data Table 1 below. As you test and modify your cars, use this table to keep track of the changes you make. Use the **CO₂ Car Inspection Guide** and check the **Rules of the Event** section in the Blastcar Guidelines and Instructions.

Car Data Table 1

Car No.:						
Version	Length (inches)	Width (inches)	Height (inches)	Weight (ounces)	Pass Inspection	Modifications

You will be able to test two cars at a time on the course. When you are ready to test a pair of cars on the course, get a Lab Leader to oversee the launcher.



Meeting 3: Build Tracks; Test and Refine Cars

Activity 2: Test and Refine Cars (40–45 minutes)

Materials List

- Blastcar Car Launch Kit (one for every two teams)
- 1 stopwatch (shared between two teams)
- Duct tape (shared between two teams)
- Towel or blanket to provide a soft stop
- Optional: ramp-building materials
- Optional: clamps and other woodworking tools as needed

You will get back into your original teams of four for this set of experiments. The following items are for your team of four.

- 1-2 cars previously built by your team
- 3 CO₂ gas cartridges per car
- 1 pin vise with 2 3/32-inch drill bits
- 2 wood rasps
- 2 keyhole saws
- Coarse and fine sandpaper
- 1 8-inch long, 5/8-inch diameter wooden dowel
- 1 tube graphite lube
- Paper towels and water
- Broom and dustpan
- 1 copy of Blastcar Guidelines and Instructions (in Blastcar kit)
- 1 ruler

Once you have a Lab Leader ready to help, connect the eyelets of the cars to the guide lines, put the CO₂ cartridges in the cars, and back them into the launcher, following the instructions in the **Running the Race** section of the guidelines.

Inspect the course area for safety compliance and make sure nobody is within 10 feet of the launcher or course.

Put one Scout at the end of the course (off to the side) with the stopwatch.

With your Lab Leader's help, call out a launch countdown and make sure that the person who is timing can clearly hear the "launch" command to start the stopwatch.

Use the Car Data Table 2 on the next page to record each test.



Meeting 3: Build Tracks; Test and Refine Cars

Car Data Table 2

Car #:					
Version	Course No.	Course Length (feet)	Time to Complete (seconds)	Problems	Improvement Ideas

After each test, discuss with your extended team (team of eight Scouts) the test run and any concerns or problems observed, and agree on what, if any, modifications you want to make.

Make your modifications and run another test. After the second test, identify any further changes you and your team want to make before the next meeting, and where and when you will get together to make those modifications.

Cleanup

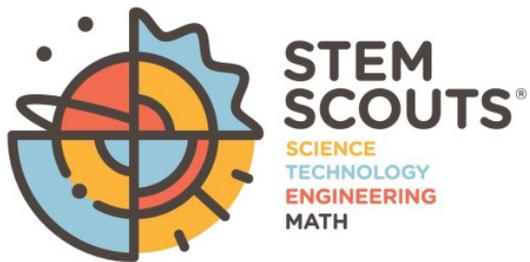
Carefully take down the courses and save all materials so that they can be used at the next meeting.

Put used CO₂ cartridges in the trash.

Clean up any wood shavings and sawdust you created when you modified your cars.

If you are going to work on your cars between now and the next meeting, check out any tools and let your Program Manager know what you are taking with you.

Clean your area, and be sure no trace is left behind.



Lab Notebook



Meeting 3: Build Tracks; Test and Refine Cars

STEM Innovator Moment Notes



Meeting 4: Race Day!



Meeting 4: Race Day!

Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

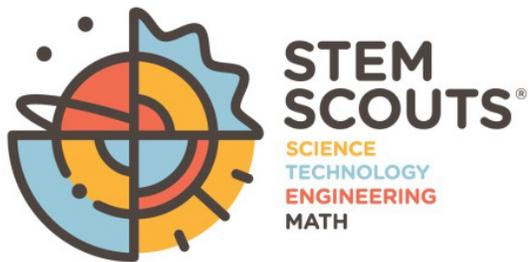
Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today's theme is *cheerful*, as in *I will be cheerful even if my team's car is not winning.*

Activity Overview

Today is race day! You and your team will reassemble your race courses if necessary and run races on the different tracks.



Lab Notebook



Meeting 4: Race Day!

Background

No additional background for today's lab.

Safety Moment

The race courses will have fishing line stretched for the entire length for the cars to connect to. This line can be almost invisible, so be careful that you don't trip over the line when walking near a race course.

NEVER put CO₂ cartridges into the cars until the cars are ready to race and are already tethered to the race line. Once the car is tethered to the race line, insert the CO₂ cartridge and then carefully move the car onto the launcher.

Everyone must stay at least 10 feet away from the launcher and race course.

Only Lab Leaders should operate the launcher.

Experiment

Get back into the same two teams of four that you have been in for previous meetings.

Activity 1: Set Up Courses (15 minutes)

Materials List

The following materials are shared between multiple teams.

- Blastcar Car Launch Kit (shared between two teams)
- Duct tape (shared between two teams)
- Trundle wheel (shared between two teams)
- Towel or blanket to provide a soft stop
- Optional: ramp-building materials

Each pair of teams should set up their course that they tested in the previous meeting.

Activity 2: The Great Race (45–60 minutes)

Materials List

The following materials are shared between multiple teams.

- 1 digital scale (shared between up to four teams)
- 1 stopwatch (shared between two teams)
- Optional: clamps and other woodworking tools as needed

The following materials are for your team of four.

- 1-2 cars previously built by the Scouts
- CO₂ gas cartridges
- 1 tube graphite lube
- 1 copy of Blastcar Guidelines and Instructions (in Blastcar kit)

Start racing! A Lab Leader will run the launcher at each course.



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Lab Notebook



Meeting 4: Race Day!

Cleanup

Carefully take down the courses and save all materials so that they can be used in Meeting 6.

Put used CO₂ cartridges in the trash.

Clean your area, and be sure no trace is left behind.

STEM Innovator Moment Notes



Meeting 5: Design a “No-Rules” Race Car



Meeting 5: Design a “No-Rules” Race Car

Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

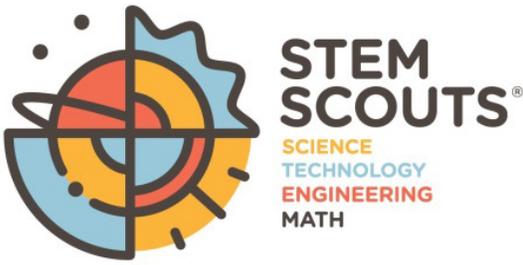
Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today’s theme is *thrifty*, as in *I will be thrifty in my use of materials and shared tools in building my no-rules race car.*

Activity Overview

You and your team will design a “no-rules” race car—where anything is allowed! You can start building the car in the lab and continue working on it at home.



Lab Notebook



Meeting 5: Design a “No-Rules” Race Car

Background

There are many websites dedicated to extreme performance tricks for CO₂ cars and pinewood derby cars.

The objective today is to design and start building the fastest car you can come up with. It is allowed to break all the rules, except for the following:

- It must weigh at least 5 ounces.
- The eyelets must have 1/4-inch clearance to the race surface.
- The CO₂ cartridge hole cannot be modified, and the cartridge must completely fit inside the hole.

You must use the wooden block and eyelets that are in the kit. You can replace anything else. Some websites that may be of interest are:

<https://gizmodo.com/the-science-behind-making-the-fastest-possible-pinewood-1563716398>

<https://auto.howstuffworks.com/auto-racing/motorsports/co2-powered-dragster2.htm>

www.science-of-speed.com/How-To/Tune?art=8021

www.co2dragsters.co.nz/assets/Uploads/CO2-Dragster-Design-and-Construction-Notes-for-Students.pdf

www.abc-pinewood-derby.com/basic-guide.php

www.wired.com/2009/02/5-easy-tips-for/

www.maximum-velocity.com/fivekeys.htm

Safety Moment

You will be using sharp woodworking tools today. Always look at the area you will be working in and set it up so that you are not going to accidentally cut the table, other furniture, yourself, or anyone else.

Sawdust and wood shavings will probably get on the floor and can make the floor very slippery. Clean up regularly and take care walking around.

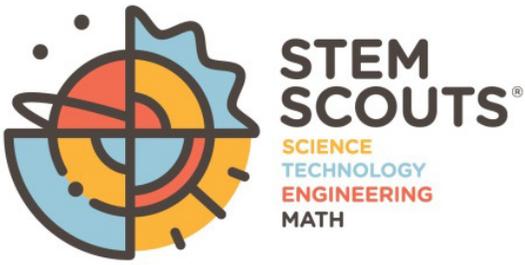
When you are sanding, be careful to not get sawdust in your eyes. If you do, get help from a Lab Manager to wash your eyes out.

Experiment

Get back into the same teams of four that you have been in for previous meetings.

Activity 1: Design Anything Goes Racer (20 minutes)

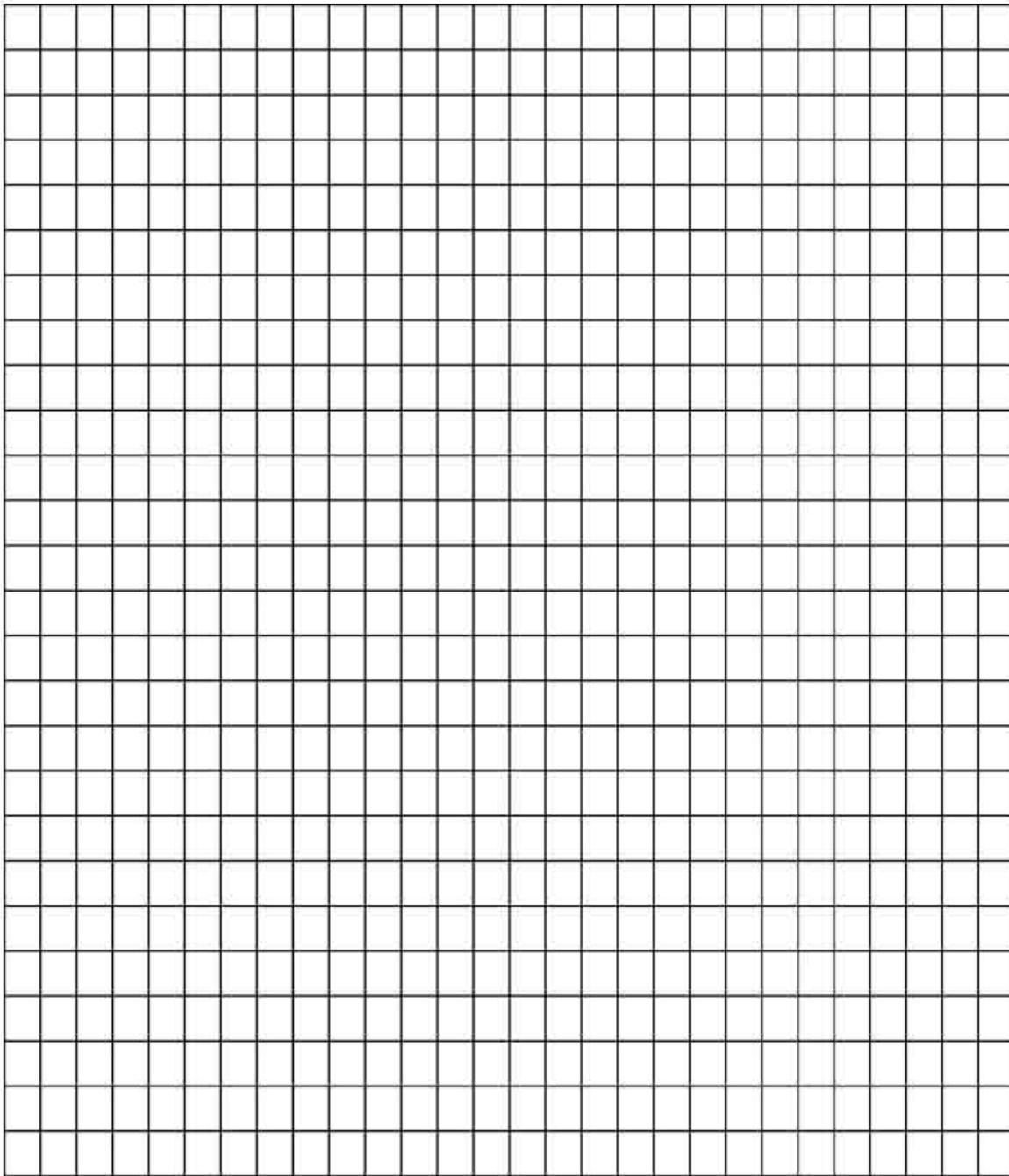
Based on everything you have learned, you and your team should design the absolutely fastest cars you can think of and that you have the ability to build between now and the next meeting.

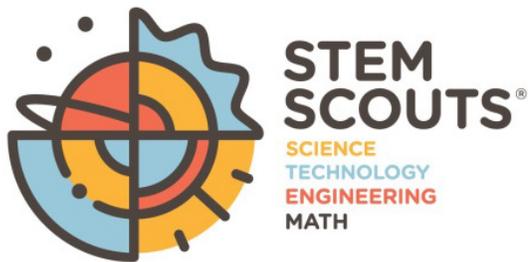


Lab Notebook



Meeting 5: Design a “No-Rules” Race Car





Lab Notebook



Meeting 5: Design a “No-Rules” Race Car

Activity 2: Build New Racer (40 minutes)

Materials List

- 2 Blastcar Car Kits
- 1 pin vise with 2 3/32-inch drill bits
- 2 wood rasps
- 2 keyhole saws
- Coarse and fine sandpaper
- 1 8-inch long, 5/8-inch diameter wooden dowel
- 1 digital scale (to be shared between up to four teams)
- 1 laptop with internet access
- Paper towels and water
- Broom and dustpan
- Optional: clamps and other wood-working tools as needed

Start building your cars. You can take them home to work on more between now and the next meeting.

Cleanup

Clean up any wood shavings and sawdust

If you are going to work on your cars between now and the next meeting, check out any tools and let your Program Manager know what you are taking with you.

Exit all applications on the laptop and fully power it down and return it to your Program Manager.

Clean your area, and be sure no trace is left behind.

STEM Innovator Moment Notes



Meeting 6: No-Rules Race Day



Meeting 6: No-Rules Race Day

Opening

The Principal Investigator will lead the group in reciting the Pledge of Allegiance and the Scout Oath and Scout Law.

Scout Oath (Scout Sign)	Scout Law (Scout Sign)
On my honor I will do my best To do my duty to God and my country and to obey the Scout Law; To help other people at all times; To keep myself physically strong, mentally awake, and morally straight.	A Scout is trustworthy, loyal, helpful, friendly, courteous, kind, obedient, cheerful, thrifty, brave, clean, and reverent.

Applying the Scout Law

Today's theme is *friendly*, as in *I will remain friendly to all Scouts as we race against each other.*



Meeting 6: No-Rules Race Day

Activity Overview

Today is race day! You and your team will reassemble your race courses if necessary and run races on the different tracks. For this race, anything goes! The rulebook just got thrown out the window!

Background

There is no additional background for today's lab.

Safety Moment

The race courses will have fishing line stretched for the entire length for the cars to connect to. This line can be almost invisible, so be careful that you don't trip over the line when walking near a race course.

NEVER put CO₂ cartridges into the cars until the cars are ready to race and are already tethered to the race line. Once the car is tethered to the race line, insert the CO₂ cartridge and then carefully move the car onto the launcher.

Everyone must stay at least 10 feet away from the launcher and race course.

Only Lab Leaders should operate the launcher.

Experiment

Get back into the same two teams of four that you have been in for previous meetings.

Activity 1: Set Up Courses (15 minutes)

Materials List

The following materials are shared between multiple teams.

- Blastcar Car Launch Kit (shared between two teams)
- Duct tape (shared between two teams)
- 1 trundle wheel (shared between two teams)
- Towel or blanket to provide a soft stop for each launcher
- Optional: ramp-building materials
- Optional: clamps and other woodworking tools as needed

Each pair of teams should set up the course they tested in the previous meeting.

Activity 2: The Great Race (45–60 minutes)

Materials List

The following items are for your team of four.

- 1 digital scale (shared between up to four teams)
- 1 stopwatch (shared between two teams)
- 1-2 cars previously built by your team
- CO₂ gas cartridges
- 1 tube graphite lube
- 1 copy of Blastcar Guidelines and Instructions (in Blastcar kit)

Start racing! A Lab Leader will run the launcher at each course.



Meeting 6: No-Rules Race Day

Cleanup

Carefully take down the courses and check with your Lab Manager or Program Manager as to what they want to save for any future races.

Put used CO₂ cartridges in the trash.

Decide within your team who gets to keep each of the four cars your team built over the course of this module.

Clean your area, and be sure no trace is left behind.

STEM Innovator Moment Notes
